1617

# NOTES

ON

# ENTOMOLOGY:

A Syllabus of a Course of Lectures delivered at

THE CORNELL UNIVERSITY,

BY

J. HENRY COMSTOCK, B. S.

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SPRING TRIMESTER, 1875.

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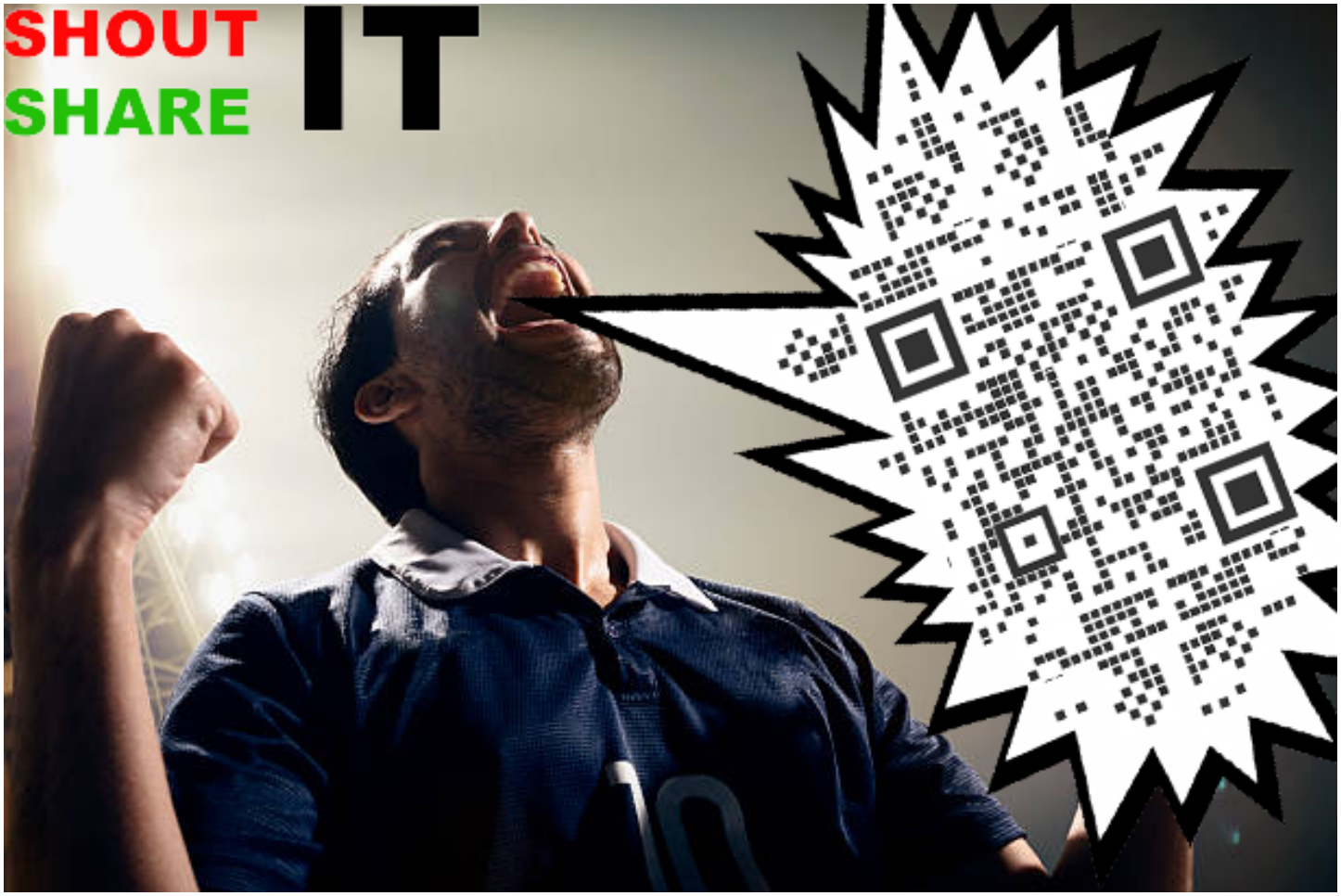
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# PREFACE.

This syllabus is not intended to take the place of a text book. It is simply a note book, in which are noted the more important points discussed in the lectures, and references to authors.

My object in publishing it is to save the students a part of the labor of taking and copying notes, thus enabling them to give more time to the study of specimens in the laboratory and in the field; and to indicate the best writings on the subjects discussed, that may be found in our library.

The blank pages are for the taking of additional notes during the lectures. The text book recommended is Packard's Guide to the Study of Insects. The titles of other Entomological works are given on page 147.

J. H. C.

ENTOMOLOGICAL LABORATORY,
*Cornell University,*
June 29, 1875.

# INTRODUCTION.

1 Object and scope of this course of lectures.

2 Method of study.

3 Division of the Animal Kingdom into Branches.

4 BRANCH ARTICULATA.—The articulate type is an elongated cylinder composed of many rings. The alimentary canal is central, the circulatory system, when present, dorsal, and the nervous system ventral.

5 By variations in the number, size, form, and grouping of the rings, or segments, and their appendages are produced all the forms of Articulates.

6 Division of the Articulata into Classes.

7 CLASS INSECTA (HEXAPODA).—Air breathing Articulates with three regions (head, thorax, and abdomen), six legs, and usually wings.

## EXTERNAL ANATOMY.

Body divided into three regions,—head, thorax, and abdomen.

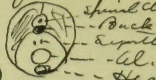
*Head*,—Consists apparently of a single segment, but in reality of several. (1, 18).*

*Appendages of the head.*—1st. A pair of antennæ. (For figures of different forms of antennæ see 15, Atlas pl. 8. On the function of antennæ see 16, II., 892; 17, VIII., 577). 2nd. Compound eyes. (16, II., 960; 18, pl. 9). 3rd. Simple eyes, or ocelli. (1, 25; 16,

* See list of books, page 147.

1 Elements of study of Entomology -
Habits more than systematic -
2 Illustrate by means of specimens &c
to learn them by sight -

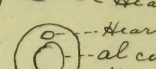
Vertebrate cross section




Vertebrate embryo (or fœtus through an articulate stage in cross section)

3 Articulata.

Cross section




"Made up" of many rings

therefore articulate

Articulata
- Worms (lowest of articulata) (aquatic)
- Crustaceans: crabs, lobsters } aquatic
- Arachnida: Spiders, scorpions &c
- Myriapoda: Centipedes, millipedes
- Insecta: reptiles, birds & abdomen

Crustaceans have 2

Arachnida
- Body consists of two regions
- Cephalothorax & abdomen
- 4 pair of legs - Resp. Aerial

Myriapoda
- air breathing art. - body one region & many legs.

Insecta
- &c 7 —

Antennae
- Function not perfectly understood
- Organs of touch and in some perhaps organs of hearing

Organs of Insecta - are important - only to system attain - whom they may be used as classification -

Compound eyes
- large organs on each side of the head
- made of many tubes & eyes
- sometimes 40 - sometimes many hundred

Ocelli
- On some insects - 3 little eyes -

Fig 1 – Labrum

Fig 2 Mandible

Fig 3 Maxillae { 1 Cardo, 2 Stipes, 3 Lacinia, 4 Palpifer, 5 Outer lobe, 6 Inner lobe, 7 Palpus }

Fig 4 Labium { 1 Palpi, 2 Ligula { 5 Lingua, 4 Glossa, 3 Paraglossae }

II., 961). 4th. Mouth-parts. The mouth-parts consist of an upper lip, *labrum*, an under lip, *labium*, and two pairs of jaws acting horizontally between them. The upper pair of jaws are called the *mandibles*, the lower pair the *maxillæ*. The maxillæ and lower lip are each furnished with a pair of feelers, called respectively the *maxillary palpi*, and the *labial palpi*. The lower lip supports also the tongue, *ligula*, which is composed of three parts, one central, *glossa*, or *lingua*, two lateral, *paraglossæ*. That part of the lower lip which supports these organs is called the *mentum*.

*Thorax*.—Consists of three segments,—*prothorax*, *mesothorax* and *metathorax*.

*Appendages of the thorax*.—1st. Legs, six in number, two to each segment; each composed of the following parts,—*coxa*, *trochanter*, *femur*, *tibia*, and *tarsus*. The tarsus is from ~~two~~ to six, usually five, jointed, and terminated by claws. 2nd. Wings, two pairs, one mesothoracic, the other metathoracic; they are not always present, and are sometimes deciduous.

*Abdomen*.—Consists of about nine segments, though Packard states that the typical number is eleven.

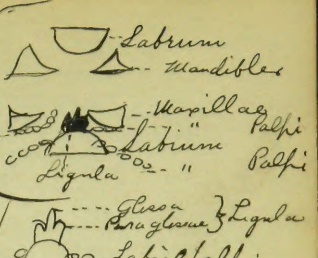
## INTERNAL ANATOMY.

*Skeleton*.—No internal skeleton as with Vertebrates. The external covering of the insect is hardened by the deposition of chitine, and serves as a framework for the attachment of muscles. Note, however, internal processes of the body wall for the attachment of muscles.

*Muscular system*.—The muscles are very numerous. Lyonnet describes 3,993 in a single caterpillar. They

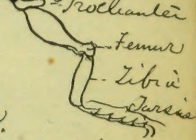
4.

Type of Insect mouth
two pairs of jaws



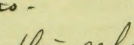

All insects do not show
all of these parts
some wht - Mouth of Worker
in which the maxillae are united in a long
flexible tube for sucking - also a flower
beetle - Bees also have their mouth parts
modified for lapping up nectar.

Thorax
Prothorax = anterior part
Mesothorax = Middle "
Metathorax = Last "

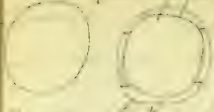



Prothorax never bears wings.

Abdomen bears no appendages for
locomotion - except in Springtails these
are the species
we see on snow
in Spring - will
jump a yard or so -




Abdomen - has the reproductive appendages
in many cases very noticable especially
in females. (Schneemann - Borers - Grasshoppers)
- although no internal skeleton yet - there
are prolongations of the outside skeleton
to which muscles are attached.



may be arranged according to their function under two heads.

1. Muscles that move the segments.
2. Muscles that move the appendages.

Those of the first class consist of numerous, "distinct, isolated, straight fibres, which are not gathered into bundles united by common tendons, or covered by tendinous sheaths to form distinct muscles, as in the Vertebrata, but remain separate from each other." (16, II., 935). The form of these muscles is determined by that of the parts to which they are attached. They have, however, this character,—their sides are straight.

Those of the second class usually differ from the preceding in being united at the distal extremity by tendons.

The strength of the muscles of insects is very great. (16, II., 942). The rapidity of action is also great. The House-fly vibrates its wings 352 times a second; the Honey-bee 440 times a second. (1, 362).

*Digestive system.*—The alimentary canal in its simplest form, as seen in the larvæ of insects, is a straight tube passing from one end of the body to the other. In the larva of Stylops and the young of bees it ends in a blind sac. In the adult insects it becomes developed into a long convuluted tube, having different parts performing different functions. (Examine models).

The appendages to the alimentary canal are the salivary glands, the Malpighian, or biliary tubes, and the so-called uriniferous organs.

*Circulatory system.*—"Abdominal dorsal vessel or heart; eight chambers, separated by very complete

1

- { segment - of section of muscle

sides of these muscles not curved.

2

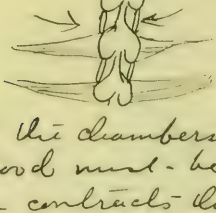
Some insects are thought to make about 15,000 times a second.

Digestive System - the Al. canal is divided into regions that have specialized functions.

Young bees feeding on nectar - do not need an opening to al. canal.

Circulatory System.

Blood flows through the body cavity in given directions but without any valves to conduct it -



wings - heart attached to the skeleton.

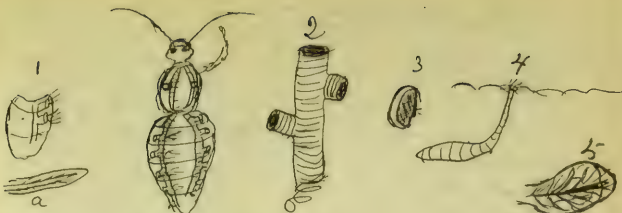
Each of the chambers can contract - and the blood must be forced forward - as one contracts the one ahead of it must dilate.

Muscles attached to skeleton dilate the heart - valves - Contraction produced by muscles around the valves themselves

valves; each receiving blood from a pericardial chamber by a pair of lateral valve-guarded orifices; current always forwards; intrinsic muscles produce contraction of chambers; dilation by lateral muscles attached to the walls of the body; from anterior chamber one vessel runs into thorax, and divides into three branches, which cannot be traced very far. The blood thus poured into the head and thorax flows backwards along the venter and sides of the body, and then to the pericardial chamber. This circulation takes place in the perivisceral cavity. The blood-corpuscles in transparent larvæ can be seen penetrating into all the interstices of tissues, and every minutest branch of the tracheal system is invested by a sheath prolonged from the perivisceral cavity, in which blood circulates on its way to the heart. (22, 70).

*Respiratory system.*—The respiratory organs consist of a system of air tubes, *tracheæ*, branching to all parts of the body, and opening externally by means of lateral apertures, *spiracles*, or *stigmata*. Take notes of the following points,—The minute anatomy of the tracheæ; the variations in number and position of spiracles; structure of spiracles; structure of branchiæ; and other modifications of respiratory organs, found in aquatic insects.

*Nervous system.*—The typical form of the nervous system of insects, as seen in larvæ, consists of a series of double ganglia, a pair for each segment, united by two longitudinal cords. These ganglia, except the cephalic, lie on the floor of the body cavity. The cephalic ganglion is placed above the alimentary canal and is proabably composed of several ganglia coalesced. From the prothoracic ganglia, the longitudinal cords




Spiracles never formed in the head - many
in any the segment - but - never in all
the segments - Spiracles may be
covered with - hairs - to keep out - dirt - or
as in Corydalus - there is a lid and
(See 3
- There are many modification of
Spiracles - to keep out - everything but - air
Trachea - branch and anastomose to an
infinite extent - they extend literally
to every part - of the body - perfectly wonderful
In insects - that - fly - the tracheae are dilated
in places to large air sacs - thus rendering
the specific gravity less - The trachea
are made up - of spirally thickened coat - so that
it - has the appearance of a spiral thread
(See 2) - Insects are aquatic - but always
air breathing - the way they get air in
larvae. Water Beetle - carry air with them
under their elytra where the spiracles open.
Rat - tailed maggots - has spiracles opening into
a bubble at the posterior end of the body.
(See (4) Some aquatic insects - have hair
like projections over the spiracles in which
the trachea extends - these insect - breathe
the same air all the time but - this air
is purified by the thin membrane
(See 5)
- at - there are some time large bladder

## Metamorphosis

All insects come from eggs when the insect-hatches from the egg it differs much in appearance from the adult. The creature really gets its growth during larval-state. The skin of larvae is naturally hard and the animal has to moult: by the skin splitting down the back. Some insects moult as many as 20 times - some much less -

(Describe Larva - Pupa & Adult - all appearing very different)

Chrysalis = pupa of Butterfly

Chrysalides (pl.) Chrysalid (sing.) chrysalids)

& plain Cocoons = cases of silk.

Insects which differ very much the adult from the larva and which have a quiescent - pupa state is Complete Metamorphosis

When the larva resembles the adult in Incomplete Metamorphosis

Larva
Pupa
Adult

pass, one on each side of the œsophagus, to the cephalic ganglion, forming a nervous collar around the alimentary canal. From each of the ganglia small nerves branch to various parts of the body. Note the cephalization of the nervous system in the adult insect.

*Reproduction.*—All insects are diœcious. Instances of agamic reproduction will be noticed later in the course.

### METAMORPHOSES.

Note carefully the meaning of the following terms.—Larva, pupa, or chrysalis, imago, complete metamorphosis, and incomplete metamorphosis.

## CLASSIFICATION.

HEXAPODA,
ἓξ six, and πούς foot.

- HYMENOPTERA,
  ὑμήν, membrane, πτερόν, wing.
- LEPIDOPTERA,
  λεπίς, a scale, πτερόν, wing.
- DIPTERA,
  δίς, two, πτερόν, wing.
- COLEOPTERA,
  κολεός, a sheath, πτερόν, wing.
- HEMIPTERA,
  ἥμι, half, πτερόν, wing.
- ORTHOPTERA,
  ὀρθός, straight, πτερόν, wing.
- NEUROPTERA,
  νεῦρον, a nerve, πτερόν, wing.

## Order HYMENOPTERA.

(*Bees, Wasps, Ants, Ichneumon-flies, &c.*)

CHAR. Wings four, membranous, with comparatively few veins; the posterior pair smaller than the anterior.

Mouth-parts formed both for biting and sucking.

Metamorphosis complete.

Abdomen furnished with a sting or piercer, in the females.

The two wings on each side are united, during flight, by a row of hooks, which are on the anterior margin of the posterior wings. Some forms, as the workers among ants, are wingless; with others the wings are deciduous.

The mandibles are formed for biting; the labium is sheathed by the long, membranous or leathery maxillæ, the three organs forming an apparatus for sucking or lapping liquid food; the maxillary and labial palpi are present.

The larvæ, excepting the young of Saw flies, which are caterpillar like, are short, cylindrical, footless grubs. The pupæ possess all of the limbs of the perfect insects, enclosed in distinct sheaths, and folded upon the breast.

In this order we see the greatest development of instinctive powers that exists among insects.

### APIARIÆ (*Bees*).

This family, which is the *Mellifera* of Latreille, includes the families *Apidæ* and *Andrenidæ* of authors.

In characterizing orders - the adult - is only used.

Posterior wings 2 - less attached to the anterior. To separate the Hymenoptera from Neuroptera - in the latter the wings are divided into very small areas - much more so than in the former.

Hymenoptera mouth.

Metamorphosis Complete: describe them.

"These insects are characterised by having the basal joint of the posterior tarsi dilated into an oblong or subtrianglar plate, which is generally hirsute on the inside, and provided with instruments for collecting and carrying pollen." (14, II., 253).

We will not discuss the groups of bees founded upon structure. In habits bees are either social, solitary or parasitic.

### 1. *Social Bees.*

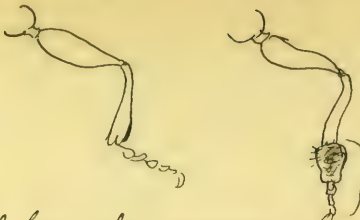
The Honey-bee, *Apis mellifica* Linn.—This insect lives in communities consisting of an immense number of individuals. They usually build their nests in hollow trees, but will appropriate any suitable place that may be furnished them; hence they are easily domesticated. The communities consist, at certain seasons of the year, of three forms of individuals,—workers, males, or drones, and a female, or queen.

The workers need no description; they are the small, active individuals that constitute the greater part of every swarm of bees. Upon them devolves all the work of the hive,—the collection of provisions, the excretion of wax, the building of combs, and the care of the young.

The males, or drones are larger than the workers, and may be easily recognized by the blunt form of each end of the body; there are only a few of them in a swarm; and they are present only during early summer; at the close of the swarming season, the remaining drones are destroyed or driven from the hive by the workers.

The female, or queen, is also larger than the workers, and differs from the drones in having a long, pointed body.

Typical mixed-leg. Bee's leg.




All bees do not carry pollen on their Tarsus - but sometimes carry it on their abdomen =

(perhaps 20000 or 300 drones in a hive.

The materials with which bees provision their hives are honey, bee-bread, propolis, and wax.

Honey is made principally from the nectar of flowers. Note manner of extracting the nectar from flowers, the form and position of the first stomach or "honey-bag," and the different views regarding the change which nectar undergoes to become honey.

Bee-bread is made from the pollen of flowers. Note manner of collecting the pollen and conveying it to the hive.

Propolis is a resinous substance collected by the bees from the buds of certain trees that produce it, as poplar. The bees collect it with their mandibles, and carry it on their hind legs in the same way as bee-bread. Propolis is more tenacious and extensible than wax, and is well adapted for cementing and varnishing.

The wax of which the combs and cells are made is an excretion of the insect. It is produced in small thin plates in little pockets, which open between the rings on the under side of the abdomen. These wax pockets are six in number. When wax is needed, some of the workers gorge themselves with honey, then suspend themselves from the roof of the hive, forming a curtain, and in about twenty four hours begin to produce wax. Note form of comb; the differences between worker-cells, drone-cells, and queen-cells; and the appearance of royal jelly.

The workers are imperfectly developed females. They are sometimes fertile; their eggs, however, produce only males.

Queens are ordinarily developed from eggs laid in queen cells, for that purpose. But if a hive becomes

Then is such a thing as poisonous honey - where the nectar is poisonous (See Xenophon)

Wax can be confused w- milk of cows.

Worker cells - smaller than drone cells - although - there are all gradations in size from worker comb w- drone comb - but - there is little doubt - after all as w- where drones & worker belong -

Worker & Drone cells - point laterally Queen cells - are much larger - and their cells - point - downward -

queenless, the workers take the partitions from between a worker cell, containing an egg or young larva, and two adjoining cells; over the large space thus formed they build a queen cell, and feed the young worker larva royal jelly. As a result of this feeding or some unknown cause the larva developes into a queen.

Note habits of the queen, and manner of swarming.

Compare specimens of Black-bees and Italian-bees.

(1, 117; 7, 356—403; 20, 313; 8, VI., 207—728; 14, II., 282).*

*Guest.*—The Bee-moth, *Galleria cereana* Fabr., is often an unwelcome guest of the Honey-bee. The eggs are laid within the hive or near its entrance. The larvæ feed upon the wax, making tunnels, which they line with silk, through the comb in various directions. The larvæ mature in about three weeks, and spin dense silken cocoons in the corners of the hive or in other protected places. The moth is dusky gray, and more or less streaked with purple-brown. It expands nearly one inch and a half. There are two broods, one appearing in April and May, the other in August.

The Humble-bees, *Bombus.*—Over forty species of this genus are known to inhabit North America. As with the Honey-bee, there are three forms of these insects,—males, females, and workers. But unlike the Honey-bees their societies exist only one season. In the fall all the Humble-bees die except the impregnated females. These hibernate; and in early spring each selects a place in which to build her nest, generally choosing a deserted mouse-nest. At first, the

* For works on practical bee-keeping see Bee Keeping by Quinby, and Langstroth on the Honey-bee.

Royal jelly - looks like Blanc Mange.

Queen cell developed from these worker cells

Queen will not allow another queen to be developed in the hive but previous to swarming the workers defend the young queen cells until later the old queen and part of the workers migrate called swarming.

Honey bees live only a short time varies, surviving one season.

Honey bee larva spins delicate cocoon about its body.

Bumble bees have more than one queen.

foundress, or queen, performs all the labor; she collects a mass of pollen, and lays a few eggs upon it; then covers these with more pollen; when a sufficient quantity has been collected, she lays more eggs, covering them as she did those first laid. The larvæ, as soon as hatched, begin to eat the food with which they are surrounded; each forming for itself a large cavity within it. In case the body of a larva appears through the mass, the breach is quickly filled with more pollen. When full grown, the larva spins about itself a silken cocoon; this is strengthened by the old bees with a thin layer of wax. In this manner is produced a very irregular comb differing much in appearance from that of the Honey-bee. When fully developed, the young bees eat their way out from their cells, and begin their duties as members of the society. Those produced in early summer are all workers, and as soon as they appear take upon themselves the provisioning of the nest, and the care of the young. The queen remains at home, doing but little more than to lay eggs. The cells from which the young bees escape are used for the storing of honey and bee-bread. "About the middle of summer eggs are deposited which produce both small females and males. All eggs laid after the last of July produce the large females, or queens; and, the males being still in the nest, it is presumed that the queens are impregnated at this time, as, on the approach of cold weather, all except the queens, of which there are several in each nest, die." (Putnam). (1, 130; 7, 213, 280, 348; 8, VI., 1; P. Huber in Linn. Trans., VI).

*Guests.*—In a nest of *Bombus pennsylvanicus*, which I kept in my study for several months, I observed the

Diagram of Bumble bees nest - ed - final

following guests:—The Humble-bee moth, *Nephopteryx Edmandsii* Pack. Of this species very many specimens were found. Its habits are similar to those of the Bee-moth, *Galleria*. From the larvæ of the Humble-bee moth I bred two parasites,—*Microgaster nephoptericis* Pack., and a larger Ichneumon-fly, which Mr. Cresson says is an undescribed species of *Limneria*. Several beetles and a cockroach were also observed in this nest.

### 2. *Solitary Bees.*

With the solitary-bees there are only two forms,—males and females. The females perform both the duties of workers and queens, each female building and provisioning a nest for her young. The habits of the following species will be carefully described during the lectures.

The Carpenter-bee, *Xylocopa Virginica* Dr. (1, 132).

The Leaf-cutter bee, *Megachile acuta* Sm.

The Leaf-cutter bee, *Megachile brevis* Say. (9. III., 210).

The Mining-bee, *Andrena vicina* Smith. (1, 144).

### 3. *Parasitic Bees.*

The parasitic-bees live within the nests of other bees. The most familiar examples are the different species of *Apathus*, which very closely resemble Humble-bees, and live in their nests. (1, 131).

### VESPARIÆ (*The True Wasps*).

The True Wasps may be distinguished from all other Hymenoptera by their wings being folded longi-

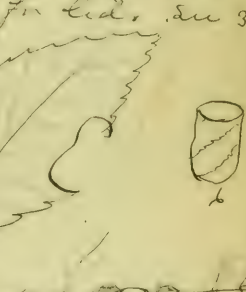
Solitary Bees.

X.V. called Carpenter bees because it makes wood-burrows 3/4 in. or hollow wood-like by means of its mandibles & mouth is in this direction. Thorax hummels are sometimes a fool in diffl. This is an arduous task. The female in Pollen lays an egg & makes a partition by putting back bits of wood & finally one 2 the part of the partition that roofs a cavern is rough but it is carefully rounded when it makes the bottom of a cell.

Megachile & hummels in wood like the above only the hummels are not so regular then visible a rose bush by cutting out long pieces of leaves and bends them up in a thimble shape tube 2 to line the wood tunnels then close cuts out a round piece for lid. See 3

Some been hummel in the ground. some in pitches plant. &c the regl. of their devel. method is like above.

Hummels been nicely shape their cells for shape of which see 4




Leaf cutter Sponge their living perhaps the Bumble Bees of kind applies me of themselves an excellent example to examine

tudinally when at rest.* In habits the wasps are either social or solitary.

### 1. *Social Wasps.*

The social wasps constitute the family *Vespidæ* of authors. These insects resemble in many respects, bees, especially Humble-bees. There are three forms of individuals,—males, females, and workers. Their societies exist only one season. In the autumn, the males and workers die. The females hibernate. In the spring, each of those that have survived the winter begins a nest, and performs all the labor till a brood of workers are developed. In the latter part of the season a brood of males and queens is produced. Unlike the bees the wasps are predaceous, feeding upon other insects; they also feed upon the sweets of flowers, fruit, etc. Their nests are either built in holes under the ground or are attached to trees, or buildings. They are made of a paper-like substance, composed of finely gnawed wood. The habits of this group are well illustrated by the following species:

The White-faced Hornet, *Vespa maculata* Linn. (1, 148).

The common, black Wasp, *Polistes metricus* Say. (1, 151).

### 2. *Solitary Wasps.*

The solitary wasps constitute the family *Eumenidæ* of authors. These wasps resemble in habits some of the solitary bees, expect that they provision their nests with insects instead of pollen and honey. Our

* A single genus of Chalcis-flies (*Leucopsis*) have the wings folded in the same manner, and a few exotic wasps (*Ceramius* and *Masaris* in part) do not fold their wings.

Wasps in making their paper - mix their finely
grained wood with - an excretion like saliva?

The wasps commence their
nest - their - after the
workers hatch them, enlarge
their nests by adding layers
of comb - and it is widened by cutting away
the paper cover

Polistes metricus makes a single comb
without - covering with - paper.

Solitary wasps - in burrowing
wood - put - their partition in of mud
and provision them with - caterpillars -
(paralyze their prey)

most common species is *Eumenes fraterna* Say, which builds small, round, mud nests upon bushes and twigs. These nests are provisioned with small caterpillars.

The families *Crabronidæ*, *Nyssonidæ*, *Bembecidæ*, *Larridæ*, *Sphegidæ*, *Pompilidæ*, *Scoliadæ*, and *Mutillariæ* include the Digger-wasps, Sand-wasps, Wood-wasps, and other insects for which we have no popular names. These families cannot be discussed in this course. But specimens of the following representatives and their nests will be exhibited and described.

Wood-wasps, *Crabro* (Fam. *Crabronidæ*). Nest made in an elder stalk, and provisioned with small flies.

The Mud-daubers *Pelopæus* (Fam. *Sphegidæ*). Nests made of mud, attached to the lower surface of flat stones or to the ceilings of out-buildings, and provisioned with spiders.

FORMICARIÆ (*Ants*).

These insects are social, and as with other social Hymenoptera there are three forms,—males, females, and workers. The males and females are winged; the workers are wingless.

Take notes of the following points:—Different forms of nests; pairing of the sexes, and the shedding of wings by the females; metamorphoses; duties of the workers; affection for young; slave-making species; "ant's cows" (*Aphides*); Harvesting-ants;* the Agricultural-ant, (17, VIII., 513); and ant-supporting plants. (Pop. Sci. Review, Jan., 1875). (1, 179; 7, 313, 206).

* See work by J. T. Moggridge, F. L. S., entitled Harvesting-ants and Trap-door Spiders.

Mud Daubers: their larva are in
silken cocoons. & feed on the paralyzing
of the spiders.

### CHRYSIDIDÆ (*Cuckoo-flies*).

These insects lay their eggs in the cells of wild bees and wasps. The larvæ either feed upon the provisions stored there or upon the young owners of the nest. (1, 191; 14, II., 174; 19, 184).

### ICHNEUMONIDÆ (*Ichneumon-flies*).

"The Ichneumon-flies are readily recognized by the usually long and slender body, the long exserted ovipositor, which is often very long, and protected by a sheath formed of four stylets of the same length as the true ovipositor. The head is usually rather square, with long, slender, many-jointed antennæ which are not usually elbowed." (1, 192).

There are many species of this family; they are parasitic on the young of other insects. The female Ichneumon-fly lays her eggs either in or upon the body of the insect upon which her young are to feed. The Ichneumon larvæ eat the fatty portions of their victim, carefully avoiding the vital organs, so that the caterpillar, or other insect as the case may be, lives on with these creatures inside its body and deriving their nourishment from it. In many cases the caterpillar lives until it has spun its cocoon, and is then killed by the parasites, which spin their cocoons within that of their victim. Other caterpillars are destroyed at an earlier stage, and the cocoons of the Ichneumons may be seen attached to their bodies or to the plants upon which they were. The following species will serve as illustrations of the habits of this family:—

*Rhyssa* (*Pimpla*) *lunator* Fab. is a large Ichneumon, furnished with an ovipositor three inches in length.

It is parasitic on the larva of *Tremex Columba* Linn., a wood boring insect.

*Ophion macrurum* Linn.—This species is parasitic on the larva of *Telea Polyphemus* Linn. Its large brown cocoons are found singly within the cocoons of this silkworm.

*Cryptus nuncius* Say is a smaller Ichneumon-fly of which thirty-five specimens were bred from a single cocoon of *T. Polyphemus*.

*Microgaster*.—Feeble caterpillars may often be seen crawling about with many, from fifty to two hundred, little white or yellow cocoons attached to their bodies; these cocoons are also found attached in clusters to plants upon which the caterpillars live. They are the cocoons of small Ichneumons which leave the body of their victim to undergo their metamorphoses. Many of these Ichneumons belong to the genus *Microgaster*.

### PROCTOTRYPIDÆ (*Egg-parasites*).

This family will not be discussed in this course.

### CHALCIDIDÆ (*Chalcis-flies*).

The species of this family are of small size, and of bright metallic colors. Their habits are similar to those of the Ichneumon-flies, they being like them parasitic on the young of other insects. They differ, however, from the Ichneumon-flies in this particular,—the majority of Chalcis flies do not spin a cocoon, but have naked pupæ.

*Pteromalus puparum* Linn. is parasitic on the chrysalides of the cabbage butterfly, *Pieris rapæ* Linn.

*Antigaster mirabilis* Walsh is parasitic on the eggs

of the Angular-winged Katydid, *Microcentrus retinervis* Burm. (3, VI., 162).

### Cynipidæ (*Gall-flies*).

Gall-flies resemble Chalcis-flies in appearance but are usually plant parasites, living in abnormal vegetable growths, called galls.

Note manner in which these galls are produced, and compare them with galls produced by Plant-lice, Bark-lice or Mites. (5, I., 101).

The True Oak Apple, *Quercus spongifica* Osten Sacken.

The Mossy Rose Gall, *Rhodites rosæ* Linn. (5, II., 213).

The Pithy Blackberry Gall, *Diastrophus nebulosus* Osten Sacken. (5, II., 159).

### Tenthredinidæ (*Saw-flies*).

The Saw-flies resemble the Lepidoptera in many respects. The larvæ are like caterpillars, usually feeding on the leaves of plants. They may be distinguished, however, by having from twelve to sixteen prolegs, while caterpillars never have more than ten prolegs. The pupæ usually transform in parchment-like silken cocoons, in the ground or on the surface, or on the limbs of trees. Adult with the three regions of the body not so well marked as in the higher Hymenoptera; head broad; thorax wide, closely resembling that of the Lepidoptera; abdomen sessile; ovipositor shaped like a saw; hence the common name of the family. (11, I., 31).

*Cimbex Americana* Leach.—The larvæ feed on the leaves of elm, birch, linden, and willow, (1, 215; 2, 518).

Cacoxenus of Leach flies - are not made
of silken threads - or Lepidoptera

The Imported Currant-worm, *Nematus ventricosus* Klug. (5, II., 15).

The Native Currant-worm, *Pristiphora grossulariæ* Walsh. (5, II., 20).

*Remedy.*—Powdered White Hellebore dusted over the infested bushes will destroy both species of currant-worms.

### Uroceridæ (*Horntails*).

The members of this family are also injurious to vegetation. The larvæ are borers, living in the trunks of trees. They undergo their transformations within their burrows. The adult insects may be distinguished from their allies, the Tenthredinidæ, by the anterior tibiæ being furnished with a single apical spur, and the abdomen of the female armed with a borer. The Sawflies have the anterior tibiæ furnished with two apical spurs, and the abdomen of the female armed with saws. Note form and habits of *Tremex Columba* Linn. (1, 228; 2, 536).

## Order LEPIDOPTERA.

### (*Butterflies and Moths*).

CHAR. Wings four, membranous, covered with imbricated scales.

Mouth-parts formed for sucking.

Metamorphosis complete.

The wings are large and extended, often connected together by a hook and bristle (frenulum). In some species, the females are wingless; in others they have only rudimentary wings.

The mouth-parts are as follows:—Labrum and mandibles rudimentary; maxillæ developed into a long sucking tube, which, when not in use, is coiled up between the well developed labial palpi; labium rudimentary. Some of the Lepidoptera do not eat anything while in the adult state; in these the maxillæ are also rudimentary.

The larvæ (caterpillars) vary greatly in form and appearance; but in general they are cylindrical, furnished with from eight to sixteen legs,—six true thoracic legs, and from two to ten fleshy, abdominal prolegs. The true legs have a hard external skeleton; they are jointed, tapering, and armed, at the end, with a little claw. The prolegs are thick, fleshy, without joints, elastic or contractile, and are generally surrounded at the extremity by numerous, minute hooks. (2. 258). Some caterpillars have enormously developed silk organs, consisting of long, simple tubes, which various purposes;—in locomotion; in the construction of webs, tents, and open by a spinneret at the under lip. The silk is used by the larvæ for cases; in the rolling and fastening together of leaves; in suspending the body, preparatory to undergoing the metamorphosis, or in the construction of a cocoon, enveloping the body, for the same purpose. Most caterpillars, larvæ of butterflies excepted, spin cocoons. In some instances (silkworms) a great amount of silk is used in the construction of the cocoon; in others only enough to fasten together the hairs of the caterpillar of which the cocoon is principally composed.

Lepidoptera almost - without exception feed upon vegetable matter - and hence are mostly noxious.

Scale.

The hairs of Lepidoptera - grow many until they are like scales are scales. The arrangement of scales on Lep. are like slingles on a roof. Sometimes the wings of moths are - hooked together.

Canker worm females are wingless - in some their " Lepidoptera. (Bandage trees with tar to prevent to canker worm from climbing trees)

Maxillae & labial palpi are only developed in Lepidoptera - (some again are never developed at - expense of their organs - Ex. their organs disappear from disuse) we all gradations in Lepidoptera from butterfly mouth-parts to long sucking tubes (. spinneret of silk worms right under its chin). Most caterpillars (Butterflies excepted) spin cocoons Hairy caterpillar use little silk using the hairs of their body fastened with silk for cocoon.

The pupa has the limbs folded upon the sides and breast; the whole being enclosed in a hard skin.

The members of this order are, as a whole, terrestrial, and injurious to vegetation.

PAPILIONIDÆ (*Butterflies, or Diurnal Lepidoptera*).

Butterflies may be distinguished from moths by the following characters:—In butterflies the antennæ are knobbed;* the body is smaller, especially the abdomen; the anterior wings, in all, and the posterior wings in most species, are carried erect when at rest; the wings of each side are not held together by a hook and bristle. The larvæ always have five pairs of prolegs, and very seldom spin cocoons. The pupæ (chrysalides) are usually angulated.

The genus *Papilio* includes the "Swallow-tail" butterflies of which there are many species.

*Papilio Asterias* Drury is a familiar example of this group. This butterfly is black, "with a double row of yellow dots on the back; a broad band, composed of yellow spots, across the wings, and a row of yellow spots near the hind margin; the hind wings are tailed, and have seven blue spots between the yellow band and the outer row of yellow spots, and, near their hinder angle, an eye-like spot of an orange color with a black centre; the spots of the under side are tawny orange." The female is larger than the male, and has the yellow spots less conspicuous. The wings expand from three to four inches. (2, 263; 1, 245).

The larvæ are green, with each segment marked by a transverse band of black, upon which is a row of yellow spots. When irritated they push from the pro-

*The antennæ of some butterflies are nearly filiform; while a few moths (Castnia) have knobbed antennæ.

thoracic ring a yellow, fleshy, Y-shaped scent organ. They feed on various umbelliferous plants, especially wild parsnip. There are two broods each season. The butterflies of the first brood appear (at Ithaca) during the latter part of May or in June (May 29th, 1875). Those of the second brood appear in July and August. The caterpillars of the second brood transform to chrysalides during the latter part of August (Aug. 26–30, 1871), and pass the winter in that state.

Discussion of dimorphism in insects, as illustrated by Papilio Turnus, and black, female variety (P. Glaucus), of trimorphism as shown by P. Ajax (P. Walshii, P. Telamonides, and P. Marcellus). Walshii is the early spring type, Telamonides the late spring, and Marcellus the summer and autumn type. (17, VIII., 257).*

The genus *Pieris* includes the cabbage butterflies; there are several species quite common, and, sometimes, they are very noxious. "They are easily recognized by the following characters:—The wings are generally white, with inconspicuous black markings, and occasionally with green or yellow underneath; they are very broad and have no scallops or indentations in the margin; the hind wings in outline resemble an egg. The palpi are rather slender, but project beyond the head; the antennæ have a short flattened knob. Their flight is lazy and lumbering. The caterpillars are nearly cylindrical, taper a little towards each end, and are sparingly clothed with a short

* The following is an interesting example of double dimorphism in butterflies:—*Lycæna violacea* Edwards is dimorphic, there being females entirely brown (southern) and others blue with only a brown border (northern); very rarely intergrades occur in W. Va. *Lycæna pseudargiolus* Boi. and Lec. is apparently a very distinct species from the above, but Mr. Edwards has bred *L. violacea*, which is an insect of early spring, from the last brood of *L. pseudargiolus*.

In Mont. Virginia - both forms
summer & Autumn and hatched
from same batch of eggs - one
found north - the other south - just
varieties of the same species.
many cases of dimorphism com-
mon - Spring. Summer & Autumn
broods are often different forms

down. They suspend themselves by the tail and a transverse loop, and their chrysalides are angular at the side, and pointed at both ends." (2,269; 5, II., 74; 3, II., 104).

*Pieris rapæ* Linn. is the most common species in Central New York. It was introduced from England, having been first taken in Quebec in 1859. Eggs usually laid on the under side of leaves; larvæ not only feed upon the outer leaves but eat their way into the centre of the cabbage, hence they are called, by the French "Ver du Cœur." There are two broods each year; the second brood hibernates in the chrysalis state.

Many of the chrysalides are destroyed by a Chalcis-fly, *Pteromalus puparum* Linn.

To the genus *Colias* belong the Sulphur-yellow butter-flies, so common in our pastures and about muddy places in our roads. The species which is so abundant in New England and the Middle States is *Colias Philodice* Godart. There are two broods of this insect, one appearing in April and May, the other in July. The butterflies, however, may be found during the entire summer. The larvæ feed on clover, lupine, garden pea, and lucerne. (2, 272; 1, 250).

*Danais Archippus* Fabr. is a very common, large, fulvous butterfly. The body, and margins of the wings are black, marked with white or yellowish spots; the veins of the wings are also black. In the males the black stripes on the veins are narrower than in the females, and there is a horny excrescence upon or near the fourth vein of the secondaries. The wings expand about four inches.

The eggs are deposited on the under side of a leaf.

Pieris rapae - probably has been introduced - in several places on this side of the continent - can be explained by simply spreading -

On working to conquer insects don't prescribe remedies - until you know the habits of the insect -

The larva is banded with yellow, black, and white, and has two pairs of long thread-like horns;—one pair on the first thoracic segment, and another pair on the eighth abdominal segment. It suspends itself by the tail when about to transform. The chrysalis is clear pale green, marked with black and golden spots.

This species feed on most of the different kinds of Milk-weed (Asclepias). There are two broods each year; the last brood hibernates in the perfect state. (3, III., 142).

The genus *Argynnis* "is readily recognized by the numerous round and triangular silver spots on the under side of the hind wings. The very spiny caterpillars have a round head, and the spines are branched, two of the prothoracic ones being the largest and reaching over the head. The angular arched chrysalides have the head either square, or slightly notched, with a smooth thorax, while on the back of the abdomen are two rows of usually gold colored tubercles. They usually feed on violets, and may be found from May to July." (Packard 1, 251). The following species are found in Ithaca,—*A. Idalia* Drury (very rare), *A. Aphrodite* Fabr., *A. Cybele* Fabr., *A. Myrina* Cramer, and *A. Bellona.*

In the genus *Vanessa* "the wings are notched and angulated or tailed on the hind edges, while the palpi are long and beak-like. The larva is cylindrical and stoutly spined, the spines being long and branched. The caterpillars are gregarious during the early stages. The head of the chrysalis is deeply notched, or furnished with two ear-like prominences; the sides are very angular, in the middle of the thorax there is a thin projection, in profile, somewhat like a Roman

nose, and on the back are two rows of very sharp tubercles of a golden color." (1, 258; 2, 295).

*Vanessa Antiopa* Linn. is a well known representative of this genus. The butterfly is large; the wings are velvety purplish brown above, with a yellowish terminal band, which is preceded by a row of violet blue spots. The under side of the wings is dark with wavy lines of deeper color, and a small central grayish point on each wing. Expands three inches.

This is one of the first butterflies to be seen in the spring, as it hibernates in the perfect state, and leaves its winter quarters during the first warm days of the season. The eggs are laid, during May, in clusters, around the twigs of those trees upon the leaves of which the larvæ feed. The perfect insects are developed during July (July 5th, 1873). A second brood appears in September. The larvæ are common on elm and willow; they also feed upon poplar and Balm of Gilead.

*Grapta* is a genus closely related to the preceding, "from which it may be distinguished by its more excised and angular wings, and its less hairy palpi. All the known species have the upper surface more or less brightly fulvous, spotted with black; lower surface crowded and veined with different shades of brown; the secondaries have a more or less angular silvery or pale golden mark, resembling sometimes the letter L or C."

*Grapta comma* Harris is the most abundant *Grapta* at Ithaca. It may be recognized by having a silvery comma in the middle of the hinder wings. The larvæ feed on hop, elm, ambrosia, and nettle. The butterflies appear early in the spring in company with *Vanessa Antiopa*.

*Grapta Progne* Harris is also very abundant. It closely resembles *G. comma* but may be distinguished from that species by the angular form of the silvery mark, which is more like a letter L than a comma. This species is said to feed upon wild gooseberry, cultivated currant and blackberry, elm, and probably honeysuckle.

*Limenitis Misippus* Fabr.—This butterfly can be recognized at once by its resemblance to *Danais Archippus*, described above. It may be easily distinguished from that species, as it is smaller and has a transverse black band near the middle of the posterior wings. Although in the adult state the resemblance between this butterfly and *D. Archippus* is great, the two species differ very much in the immature states. The mature larva of *L. Misippus* "presents a roughened tubercled appearance and varies much in color, the predominant colors being moss-green, brown, and creamy white; the moss-green parts being studded with beautiful light blue points. The pupa is marked with burnt umber brown, ash-gray, flesh-color, and silvery white, and is characterized like that of the other species of the genus, by a curious thin almost circular projection, which has been likened to a Roman nose, growing out of the middle of its back." (3, III., 153, Fig. 70.)

This species feeds upon willow, poplar, and plum; it is two or three brooded, differing in different parts of the country; it winters in the larval state.

The larvæ of the autumnal brood construct dwellings, in which to pass the winter. These are made by first fastening, by means of silk, a leaf to the twig upon which it grew. The tip of the leaf, except the

midrib, is then gnawed away; the edges of the remaining part are folded together, and fastened with silk, forming a tube, which is lined with the same material. This tube with the projecting midrib resembles in form the leaf of a miniature pitcher-plant.

Note the interesting fact that only the autumnal brood exhibits the "architectural instinct."

*Satyrus Nephele* Kirby is a dark brown butterfly, common in our woods, orchards, and meadows. The fore wings have each two black eye-like spots, with a pupil; these spots are sometimes surrounded by a yellowish diffuse ring. The hind wings have each a single smaller eye-spot above, and five or six spots beneath.

This species will serve as an illustration of a group of butterflies consisting of several genera (*Satyrus*, and its allies, *Chionobas*, *Hipparchia* and *Neonympha*). The members of this group are wood-brown and ornamented, especially beneath, with eye-like spots, and have the wings entire, with the veins of the fore-wings swelled at their base, and the discal area open on the hind wings. They have a short, quick, jerky flight. The caterpillars are green and smooth, spindle-shaped, or cylindrical, tapering at both ends; the hind end is notched, and the head entire or notched. They live mostly on grasses. The chrysalis is either oblong and somewhat angular on the sides, with the head notched, and two rows of pointed tubercles on the back, or short and rounded, with the head obtuse." (1, 262; 2, 303).

"The small delicate Theclas and Lycænas are often of great beauty and interest. The palpi are elongated, the wings entire, and the hind pair are often once or

double tailed. The larvæ are slug-like, as when moving on their short feet, sixteen in number, they seem rather to glide than walk. They are oval, flat below and rounded above, both extremities being much alike, with the small head retracted within the body. The short and thick chrysalides are flat beneath, but very convex above and rounded at each end." (1, 264).

"The Hesperians, or Skippers, are a large group of small, dark dun-colored butterflies, whose antennæ have the knob curved like a hook, or ending in a little point bent to one side, reminding us of the antennæ of the Sphinges. They are moth-like in their motions, form, and larval characters. They are stout bodied, with large heads and prominent eyes, and thick palpi, almost square at the end. The larvæ are spindle-shaped, naked, and with a remarkably large head. They are solitary, and often hide in folded leaves like the *Tortricidæ*, transforming in a rude cocoon of dead leaves or stubble, held together by silken threads. The pupæ are somewhat conical, like those of moths, smooth and generally covered with a bluish white powder. They are fastened by the tail and a slight band of threads within their rude cocoons. We have many species in this country." (1, 269).

SPHINGIDÆ (*Hawk-moths or Humming-bird moths*).

These moths may be easily recognized by the form of the body, wings and antennæ. The body is very stout, spindle shaped; wings long, narrow, and very strong; antennae prismatic in form, and more or less thickened in the middle or toward the tip, which is frequently recurved in form of a hook. The sucking tube

Sphincter ani [illegible]
[illegible] (Honeycomb) in the
[illegible] radial [illegible]
[illegible] - much larger than
the body -

(maxillæ) is very long, being in some instances twice as long as the body.

Most of these insects fly in the twilight and, at that time, are frequently mistaken for humming-birds, on account of their habit of remaining poised in the air, by means of their powerful wings, while extracting the nectar from flowers.

The larvæ feed upon the leaves of various plants. When full grown they are usually of large size, with a naked, cylindrical body, five pairs of prolegs, and a horn or tubercle on the eighth abdominal segment. The name Sphinx was given to these insects on account of the peculiar attitude of the larvæ when at rest. When full grown they descend into the ground, where they make rude earthen cells in which they undergo their transformations. The pupæ are naked, conical, and often furnished with a free tongue-case, resembling the handle of a jug. "Most of the species fly in June and July. The larvæ transform in the latter part of August and September." (1, 271).

The Tomato-worm, Potato-worm, or Northern Tobacco-worm, *Macrosila* (*Sphinx*) *quinque-maculata* Haworth, is one of the best known members of this family. The perfect insect may be found from June to autumn, although most of them leave the pupæ state during July. It is a large moth, expanding four and one half inches, and has five yellow spots on each side of the abdomen.

The eggs are laid on the leaves of tomato, potato, tobacco, and sometimes bittersweet (*Solanum Dulcamara*). The larvæ feed on these plants, and are most abundant during July and August. When full grown, the body is three inches in length, and dark green,

Epilogue single bracket -

with a series of greenish yellow angular bands on the side. The stories of the poisonous qualities of these larvæ are without foundation. The pupa is two and one fourth inches in length, with a large free tongue-case. (2, 320; 3, I., 95; 4, IX., 211).

*Remedy.*—Hand picking.*

The Southern Tobacco-worm is *Macrosila* (*Sphinx*) *Carolina* Linn. This insect closely resembles *M. quinque-maculata* both in appearance and habits, and is often confounded with that insect.

The clear-winged Sphinges, *Sesia.*—Note form and habits of *Sesia Thysbe* Fab., and compare with the following family.

## ÆGERIADÆ (*Clear-winged moths*).

The Clear-winged moth are remarkable for their resemblance to bees and wasps, a resemblance due to their clear wings and gay colors. They "are readily recognized by their small size, narrow wings, thickened antennæ, and by the tufts at the end of the body, which they can spread out fan-like. They fly very swiftly in the hottest sunshine. The larvæ are borers, living mostly in the hollowed stems of plants. They are whitish, cylindrical, with sparse, short, inconspicu-

* The following is from Prof. Riley's Fifth Report: "Mr. E. M. White of West Fork, Reynolds county, sends me the following account of his method of counterworking the Tobacco or Potato worms. 'In every tenth hill on the outside of my field, I sow the seed of Jamestown Weed, *Datura stramonium*, instead of setting tobacco plants. As the Daturas grow up, I pull out all but two to each hill, and when these are in bloom, I go around every evening, and, after destroying all but two flowers, pour into these a few drops of common fly poison, mixed with sweetened water and whisky, [the fly stone of druggists is intended, it being an ore containing cobalt and arsenic]. The moths sip the poison, and die from it, and I find them scattered over the farm for a space of several hundred yards.'

Mr. White's testimony corroborates that of many others who have killed these large Sphinx moths in the same manner."

Sesia - Forma non elevata in alto
da, time. Ehrh. subspilata - Sesia
a great - resemblance to Sphinx larva

ous hairs, and they have no anal horns. They transform in a rude, oblong, oval cocoon, constructed of the chips they make in boring out their tunnels, cemented by a gummy secretion. The pupæ are chestnut-brown, with transverse rows of short teeth on the abdominal rings, by which they make their way out, partly through the hole previously made by the larva for the exit of the moth. The shell of the chrysalis is often left protruding from the hole." The family is quite injurious to vegetation (1, 277).

The Peach-tree borer, *Ægeria exitiosa* Say.—This insect has destroyed most of the peach trees in this part of the country, and one can hardly find here a peach tree that is not infested by it. The eggs are oblong oval, dull yellow, and are deposited on the bark of the tree near the ground. The larvæ work downwards in the bark of the root, where they often completely girdle the tree. I have found them nine inches below the surface. Their burrows become filled with gum, which enables one to easily detect their presence. When full grown the larva comes to the surface of the ground and makes a cocoon of borings fastened together with silk. These cocoons are usually placed against the side of the root, but they are sometimes found in the ground several inches from the tree. The perfect insects appear from May till October; but nearly all the specimens that I have bred appeared between June 28th and July 5th.

Note great difference between the two sexes. (4, I., 108; 2, 331; 3, I., 47).

*Remedies.*—Mounding the trees, see 5, I., 180; hot water, 6, I., 27; remove earth with a trowel, and destroy the larvæ.

J.H.C. has never found a
[illegible] brine [illegible] without bacteria

Yeasts vegetation will begin
140 F. hot-water.

The Currant borer, *Ægeria tipuliformis* Linn. This insect is closely allied to the preceding species, but is much smaller. The eggs are laid on the twigs. The larvæ penetrate the stem, and devour the pith, in this way making a burrow in which they live and undergo their transformations. The perfect insects appear in June.

*Remedy.*—Burn infested twigs in May or earlier.

### ZYGÆNIDÆ.

Not discussed in this course. The students, however, are advised to examine the specimens illustrating it, especially those of *Meganthymus yuccæ* Boisduval.

### BOMBYCIDÆ (*Spinners*).

This family is characterized by Packard as follows: "Their thick heavy bodies, and small sunken heads, and often obsolete mouth-parts (the maxillæ or tongue being especially short compared with other moths), and the broadly pectinated antennæ, together with their broad, often falcate wings and sluggish habits, notwithstanding numerous exceptions, afford good characters for distinguishing them. The clypeus is large, the antennæ are inserted higher up than in other moths, so that when in doubt as to the position of some aberrant forms, a reference to these characters enables us to determine quite readily as to their affinities."

The White marked Tussock moth, *Orgyia leucostigma* Sm. and Abbott.—The larvæ is a very beautiful, slender caterpillar, with pale yellow hairs and tufts, two black pencils projecting over its head and one over

Cumani - over.
onfecta turgo mane it manifest
Uti leones tumuli pilon dom
Dafne Uti leones appium

the other extremity of its body, its head and two small protuberances on the hind part of the back bright coral red. They are common on apple, witch-hazel and many other trees. The species is two brooded. The moths of the first brood appeared July 11th; those of the second brood probably appear late in September. Soon after appearing they pair, and the wingless, ash-gray, female lays her eggs upon the cocoon, covering them with a frothy substance. The eggs of the fall brood do not hatch till the following spring. The male moth is dull smoky or sooty brown, with a white dot near the tip of its fore wings.

*Remedy.*—Collect and destroy the eggs during the winter months; they may be easily detected by the presence of one or more leaves fastened with the cocoon to the twigs of the trees upon which the larvæ feed. Be careful not to destroy cocoons containing parasites. (3, I., 144).

The Apple-tree Tent-caterpillar, *Clisiocampa Americana* Harris, is the name of the "Apple-tree worms," which build the large, triangular, silken webs in apple and wild cherry trees during spring. The eggs are laid in a cluster, forming a ring about a twig. They hatch in the spring, at the time the leaves appear, becoming full grown about the middle of June. At this time they leave the trees in search of a place to spin their cocoons. The cocoons may be recognized by having a yellowish-white powder mixed with the silk. The pupa state lasts about three weeks. The moth is dull yellowish-brown or reddish-brown, with two transverse whitish or pale yellowish lines on the anterior wings.

*Remedies.*—Destroy egg clusters during winter.

Apple - Tree Leaf - Caterpillar - Spin
a thread after it - as it goes
out - to feed - so making silken
threads all over the tree

Destroy larvæ as soon as the tents appear; do this early in the morning or late in the evening, when they are all in their tents. (3, III., 117; 4, II., 181; 5, II., 143).

The Tent-caterpillar of the Forest, *Clisiocampa sylvatica* Harris.—Note habits, and compare with the preceding species. (3, III., 121).

The Fall Web-worm, *Hyphantria textor* Harris.—Eggs laid in a cluster on a leaf; they hatch during June, July, and August. The larvæ spin a web under which they live and feed, increasing the size of the net as they require more food. They are found on many kinds of trees, but especially ash. This species is generally single brooded, and winters in the pupa state. The moth emerges during May or June, and is pure white.

Compare this species with the Apple-tree Tent-caterpillar, and note differences in habits.

*Remedy.*—Destroy the larvæ as soon as the webs appear. This may be done at any time of the day. (3, III., 139).

To the old genus *Attacus* belong several very large common moths. The larvæ live on various fruit and forest trees, and spin dense silken cocoons, which, in some instances, at least, might be utilized in the manufacture of silk. The following species are found at Ithaca.

*Telea* (*Attacus*) *Polyphemus* Linn.—The moth is brown with large transparent eye-like spots in the centre of the wings. It expands five inches. The larvae feed upon oak, walnut, hickory, bass-wood, elm, maple, hazel, apple, rose, quince, thorn, plum, choke-cherry, sycamore, poplar, birch, honey-locust, blue-

berry, and willow. The cocoon is oval, closed at both ends and generally fastened to leaves with which it falls. (3. IV., 125).

*Actias* (*Attacus*) *Luna* Linn.—The body is white, with clear green wings; each wing marked with an eye spot; a reddish brown band extends across the thorax and the whole length of the upper edge of the fore wings; posterior wings prolonged into long tails. This moth expands nearly five inches. The larvæ feed upon walnut, hickory, sweet gum, beech, birch, willow and plum. The cocoon is similar in form to that of *Polyphemus*, but it is not so dense, and is sometimes of a brown color. (3, IV., 123).

*Samia* (*Attacus*) *Cynthia* Drury is an introduced species of which a few specimens have been taken in this place. Many specimens have been bred here, by members of the University, from eggs obtained in Brooklyn, L. I. This is probably the explanation of its occurence in this locality. The larvæ feed upon the Ailanthus. The cocoon is similar to that of *Promethia*. The goods known by the name of *Ailantine* are made from the cocoons of this species. (3, IV., 112).

*Callosamia* (*Attacus*) *Promethia* Drury. This species is closely allied to the above. The sexes differ greatly. "The male is of a deep smoky brown color on the upper side, and the female light reddish brown; in both, the wings are crossed by a wavy whitish line near the middle, and have a wide clay-colored border, which is marked by a wavy reddish line; near the tips of the fore wings there is an eye-like black spot within a bluish white crescent." (2. 390). Expands three and one half inches. The larvæ are found principally on

ash and wild cherry; they also feed upon sassafras, tulip tree, sweet gum, spice bush, maple, plum, poplar, Azalea, Cephalanthus, snowdrop tree, barberry, birch, bayberry, and lilac. The cocoon is usually enveloped by a leaf, the petiole of which is fastened to the branch with a silken band. The cocoon is open at one end to allow the escape of the imago. (3, IV., 121).

*Callosamia* (*Attacus*) *angulifera* Walk.—A single specimen of this rare insect was bred from what I had supposed to be a cocoon of *Promethea*,

*Platysamia* (*Atticus*) *Cecropia* Linn.—"The ground-color of the wings is a grizzled dusky brown, with the hinder margins clay-colored; near the middle of each of the wings there is an opaque kidney shaped dull red spot, having a white centre and a narrow black edging; and beyond the spot a wavy dull red band, bordered internally with white; the fore wings, next to the shoulders, are dull red, with a curved white band; and near the tips of the same is an eye-like black spot, within a bluish-white crescent." (2. 385). The cocoons are oblong oval, fastened by one side to a twig, and open at one end. They have been found on the following plants, upon most of which the larvæ probably feed: apple, pear, cherry, current, barberry, hazel, plum, hickory, blackberry, elderberry, elm, lilac, red-root, maple, willow, and honey locust. (3, IV., 103).

*Seriacaria* (*Bombyx*) *mori* Linn. is the Chinese or Mulberry silkworm, from the cocoons of which most of the silk of commerce is made. (3, IV., 75; 20, 214).

NOCTUIDÆ OR NOCTUÆLITÆ (*Owlet-moths*).

The Owlet-moths "are characterized by their thick

bodies, the thorax being often crested, by the stout and well developed palpi, and the simple and sometimes slightly pectinated antennæ. The fore wings are small and narrow, and the rather large hind wings are, when at rest, folded under them, so that the moth looks much smaller than when flying. They fly swiftly at night, and are attracted by light." (1, 302).

The most important are the Cut-worms, or Surface caterpillars, which belong to the following genera: *Agrotis*, *Hadena*, *Mamestra*, and *Celæna*. (4, IX., 237; 3, I., 67).

The habits of Cut-worms are, in general, as follows: Eggs laid during mid-summer. The larvæ as soon as hatched feed upon the roots of grass and other plants, doing but little injury during the first season. They winter in the ground at the depth of three or four inches. In the spring they come to the surface, and are very destructive to the young and tender plants. When full grown they descend three or four inches into the ground, and form oval cells within which they undergo their transformations. The pupa state lasts about four weeks.

Some of the exceptions to the above are as follows: Many species ascend trees during the night, and destroy the young buds; some are two brooded; a few pass the winter in the pupa state.

### GEOMETRIDÆ or PHALÆNIDÆ.

"The Geometrids are easily known by their slender, finely scaled bodies and broad thin wings, which in repose are not folded roof-like over the body, but are spread horizontally and scarcely overlap each other. The antennæ are usually pectinated. They are deli-

Remedy for Cut-worms. Take
a brown stick, sharpen it: make
holes in the ground a foot deep
making the walls hard & smooth
they will crawl into them for
hiding, and on [illegible]

cate, pale, often greenish or yellowish moths, and fly more by day than the noctuids. The palpi are short and slender, and the tongue, or maxillæ, is weak and short." (1. 318).

The larvæ are "Measuring worms," or "Loopers," and rarely have more than two pairs of prolegs.

The Canker-worm, *Anisopteryx vernata* Peck.—The eggs are laid in the early spring and late in autumn upon the bark of apple, cherry, plum, elm, and other trees. The larvæ hatch during May and destroy the young leaves. When full grown the larvæ descend to the ground and undergo their transformations in rude earthern cocoons. The perfect insects appear in the autumn or following spring.

*Remedy.*—Prevent the wingless females from climbing the trees and depositing their eggs upon them, by means of bandages, covered with coal oil or printer's ink, and bound around the trunks of trees. (2, 461; 3, II., 94).

### PYRALIDÆ (*Snout-moths*).

These moths are easily recognized by their long, slender, compressed palpi, which give them their popular name.

The Bee-moth, *Galleria cereana* Fab., and the Humble-bee moth, *Nephopteryx Edmandsii* Pack., already discussed, are members of this family.

### TORTRICIDÆ (*Leaf-rollers*).

"The Leaf-rollers are best characterized by the shortness of the palpi, which project beak-like, and are rarely long enough to be curved in front of the head; and by the oblong fore wings. They are of

small size, rarely expanding over an inch, and are folded roof-like over the body. The fore wings are broad, compared with those of the Tineidæ, and are much rounded on the costa." (1. 332).

The larvæ of many species roll up leaves, fasten them together with silk, and live inside of the rolls thus formed.

The Codling moth or Apple-worm, *Carpocapsa pomonella* Linn.—The moth appears in early summer and lays its eggs on apples and pears, laying them singly in the blossom end of the fruit. The larva, when hatched eats its way to the core, usually causing the fruit to fall prematurely. When full grown the larva burrows out through the side of the fruit, and undergoes its transformations within a cocoon, under the rough bark of the tree, or in some other protected place. This species is both single and double brooded. The larvæ winter in their cocoons, transforming to pupæ during early spring.

*Remedies.*—Pick up and destroy the infested fruit as soon as it falls, or allow hogs to feed upon it. Trap the larvæ by providing a place for them to spin their cocoons. This may be done in many ways; the most effectual way is to put a band of hay or other material around the trunk of the tree.*

## TINEIDÆ.

"The Tineids are a family of great extent, and the

* The following are Prof. Riley's rules for the use of these bands: "1st, the hay-bands should be placed around the tree by the first of June, and kept on till every apple is off the tree; 2nd, it should be pushed up or down, and the worms and chrysalids crushed that were under it, every week, or at the very latest, every two weeks: 3rd, the trunk of the tree should be kept free from old rough bark, so as to give the worms no other place of shelter. and, 4th, the ground itself should be kept clean from weeds and rubbish." (3. I., 66).

species are very destructive to vegetation, having innumerable modes of attack. They may be distinguished from the Tortricidae by their smaller size, while the narrow wings which lie on the top of, or are rolled around the body when at rest, are often falcate, or pointed acutely, and edged with a long fringe of exceeding delicacy. The maxillary palpi are greatly developed, while the labial palpi are of the usual size, and usually recurved in front of the head. The antennæ are long and filiform." (1, 346).

The larvæ are mostly leaf miners; many are case bearers.

Note form and habits of the following species:

The Clothes moth, *Tinea flavifrontella* Linn. (1, 346).

The Indian meal moth, *Tinea zeæ* Fitch. (4, II., 320).

### PTEROPHORIDÆ (*Plume-moths*).

These moths "may be at once known by their fissured and plumed wings. The body is long and slender, with long antennae and legs. They are the lowest moths, the long slender abdomen and fissured wings being marks of degradation. The larvæ have sixteen legs, and are rather hairy. They form no cocoon, but, fastening themselves by the tail to a leaf or stem, shed their larva-skins and appear in the pupa state. Some of the pupæ are nearly as hairy as the larvæ, others are quite naked. Most of the larvæ feed in the early summer months, and the perfect insects appear rather later, though some may be seen in spring." (1, 35[6]).

# Order DIPTERA.

(*Flies, Mosquitoes, Gnats, &c.*)

CHAR. Wings two, mesothoracic. Metathorax furnished with a pair of knobbed threads, (halteres, balancers, or poisers).

Mouth-parts formed for sucking.

Metamorphosis complete.

In many species the wings are accompanied, at the base, by a small wing-like membrane (alulet). The poisers are probably the homologues of the hind wings of four-winged insects; and "are the most characteristic organs of the order, being present even when the wings themselves are wanting." (14, II., 499).

The mouth-parts are typically composed of six setiform organs (labrum, pair of mandibles, pair of maxillae, and the lingua) partially enclosed in a sheath (labium), and a pair of one or more jointed maxillary palpi. Labial palpi wanting.* (14, II., 496, 498; 1, 359).

Larvæ (maggots) fleshy, footless, cylindrical. In the majority of species they have only two spiracles, which are situated at the posterior end of the body. Pupæ usually encased in the dried skin of the larvæ, some naked, others with a cocoon. The pupæ of the Culicidæ are active.

This is a large order, both in number of species and individuals. The species differ much in habits. Some are very annoying to man. Familiar examples are the mosquito, which attacks his person; the flesh-flies, which infest his food; the bot-flies, and gad-flies, that torment his cattle; and the gall-gnats, that destroy his crops. Other species are very beneficial. Those belonging to the Syrphidæ, and the genus Tachina, destroy

* In the Pulicidæ the maxillæ are small triangular scales, the labium is minute, and furnished with three-jointed palpi. (14, II., 488).

many noxious insects; and very many species, while in the larval state, feed upon decaying animal and vegetable matter, thus acting as scavengers.

Although the habits of these creatures, which revel in all kinds of filth are very disgusting, we cannot help admiring that arrangement by which a mass of filth, instead of being left to poison the atmosphere, is transformed into myriads of living beings, whose swift flight and delicate forms lend life and beauty to the landscape.

Only a few species, illustrating the more important families, can be discussed in this course.

## CULICIDÆ (*Mosquitoes or Gnats*).

Most N. Am. species of this family belong to the genera Culex and Anopheles. These genera may be separated as follows: "The palpi of Culex (males) are *longer* than the proboscis, whilst in Anopheles the palpi are *of the same length*." (21, pl., A).

*Culex*.—More than thirty N. Am. species have been described. Eggs laid in boat-shaped masses. Larvæ called "wigglers," aquatic, breathing through a respiratory tube, placed on the eighth abdominal segment. Pupæ active, respiratory tubes *thoracic*, two in number. "The female insects sting severely and suck blood, whilst the males content themselves with the juices or nectar of flowers." (21, 16). The larvæ are beneficial, acting as scavengers. There are several broods each year.

## CECIDOMYIDÆ (*Gall-gnats*).*

These insects lay their eggs in stems, leaves, buds, and flowers of various plants. The larvæ produce

* See monograph of this family by Baron Osten Sacken in the Smithsonian Monographs of North American Diptera, Part 1. p 173.

galls or other deformities, or simply arrest the growth of the infested part.

The Hessian-fly, *Cecidomyia destructor* Say.—Supposed to have been brought to this country in straw by the Hessian troops, hence the name. "The larvæ live between the leaf and main stalk, near a joint, sucking the sap and weakening the plant. The pupa, which is of a bright chestnut color and resembles a flax seed, is formed in the larva-skin and developed in the same place. The flies appear in April and May and deposit their eggs in the crevices of the blades. Some of the insects probably come out in autumn. The larvæ do much injury to wheat, barley, rye, etc." Glover, 21, 7.

*Remedies.*—Burn stubble immediately after harvest. Sow fall wheat late. (2, 568; 4, VII., 133; 1, 374).

The Wheat-midge, *Diplosis* (*Cecidomyia*) *tritici* Kirby.—"Larvæ of a red color. This insect made its first appearance in 1830, in Canada, from the emptying of a straw bed by a Scotch emigrant, and spread in a circle of about thirty miles in a year, at first. Eggs from 2 to 12, deposited in the opening flowers of wheat, etc., in June and July. These hatch, in 10 to 12 days, into minute reddish, or orange colored larvæ, which live in the chaffy scales of barley, grass, oats, rye, and wheat, feeding on the pollen and milky juices of the grains, causing them to shrivel up and become comparatively worthless. The pupæ are found a little below the surface of the earth, in a delicate filmy cocoon glued to the surrounding grains of earth. (Harris, however, states that the pupæ transform without a cocoon). The following season the pupa works its way to the surface of the earth, and the fly appears in

May or June. Some flies, however, are said to appear as perfect insects in July or August of the same season. In 1854 the amount lost by the ravages of the Wheat-midge in New York, was estimated by the N. Y. St. Ag. Soc. to exceed fifteen million dollars; and in 1857 the same insect destroyed one-third of the crop in Canada, amounting to eight millions of bushels." Glover, 21, 19.

*Remedies.*—Deep plowing in the fall or spring. Sow wheat late. (1, 375; 2, 587; 4, VI, 3).

### TIPULIDÆ (*Crane-flies*).*

These flies are easily recognized by their large size, long legs, and slender antennæ and palpi. "The presence of a transverse V-shaped suture across the mesonotum, would alone be sufficient to distinguish the *Tipulidæ* from the neighboring families." (Osten Sacken).

The larvæ live in various situations, in the soil, in vegetable mould, in wood, and even upon the leaves of plants. Some of them are destructive to the roots of grass, grain, and vegetables. Some larvæ of this family have a curious habit of collecting together by thousands, and, adhering to each other by a sticky substance, forming a serpent-like animal, sometimes several yards in length, which travels over the ground as an individual.

Three-banded Crane-fly, *Tipula trivittata* Say.—Most common species in Ithaca. Adult occurs in great numbers in May and June. Habits of larva?

* See monograph of this family, by Baron Osten Sacken, in the Smithsonian Monograph of North American Diptera, Part IV.

### PULICIDÆ (*Fleas*).

This group constitutes the order Aphaniptera of Kirby, Westwood, and many other writers. For characters, see 1, 388; 14, II., 488.

The Human-flea, *Pulex irritans* Linn., is an example of this family.

### SYRPHIDÆ.

Many species of this family are remarkable for their resemblance either to wasps, or bees. They hover about flowers and extract nectar from them. The larvæ of many species are very beneficial, as they feed upon Plant-lice. Some live in decaying wood; others live parasitically in the nests of bees; a few are aquatic.

See specimens of *Microdon globosus* Fab., larva, puparum and adult; Rat-tailed Maggots, *Eristalis transversus* Wied., larva and adult; and *Volucella evecta* Walk. Note resemblance of Volucella to a bee.

Discussion of mimicry. (See Wallace on Natural Selection, p. 75, and 3, III., 159). Examine carefully specimens of the following insects, and note resemblances. Volucella (Dip.) and small worker Humble-bees (Hym.); Laphria (Dip.) and Bombus (Hym.) Spilomyia (Dip.) and Vespa (Hym); Limenitis disippus Godt. (Lep. Nymphalidæ) and Danais archippus Fabs. (Lep. Danaidæ).

### ŒSTRIDÆ (*Bot-flies, Breeze-flies.*)

"In these flies, so interesting in their habits, the body is stout, hairy, like the Humble bees, and they are easily recognized by having the opening of the mouth

very small, with rudimentary oral organs. The middle part of the face is exceedingly narrow, and the minute antennæ are inserted in rounded pits." Packard 1, 403.

The Horse Bot-fly, *Gastrophilus equi* Fabr.—Eggs attached to the hairs on legs and shoulders of horses. Larvæ licked off by the animal's tongue and swallowed with the food. They fasten themselves to the walls of the stomach, and remain there until full grown. They then pass from the animal with the excrement, and undergo their transformation in the dried skin of the larva. (13, 1869, p. 96).

Bot-fly of the Ox, *Hypoderma bovis* DeGeer.—Eggs deposited on backs of Cattle, Larvæ pierce the skin and live under it in tumors produced by their irritation. When full grown they leave the tumors and fall to the ground, where they transform within the dried skin of the larva. (13, 1869).

The Sheep Bot-fly, *Œstrus ovis* Linn.—Eggs or young larvæ deposited in the nostrils of sheep. Larvæ live in the frontal sinuses, where they feed upon the mucous. They are very injurious to the sheep, causing vertigo or "staggers." Pupa state passed beneath the surface of the ground, in the dried skin of the larva. (3, I, 161).

## MUSCIDÆ.

The following species will serve as illustrations of the form and habits of the members of this very large family.

The House-fly, *Musca domestica* Linn.*—Eggs,

*See paper by Packard, on the transformations of the common House-fly, from the Proceedings of the Boston Society of Natural History. Vol. XVI, Feb. 1874.

about one hundred and twenty in number, laid in horse manure. Larvæ become full grown in from five to seven days, having moulted twice. Pupa state lasts from five to seven days. Adult insects are common during the warm parts of the year, and hybernate through the winter.

The Flesh-fly, *Sarcophaga carnaria* Linn.—Female viviparous, Larvæ feed upon carion, and are occasionally found in wounds and sores of man and cattle. It is said that sometimes a single female of this species contains 20,000 eggs. See Am. Nat. Vol. VII., p. 193 for figures of larva, puparium and adult.

The Cheese Maggot, *Piophila casei* Linn.—Larvæ, called "skippers" or "Cheese maggots," live in cheese, bacon, and other fatty substances. Note manner of leaping. (5, II., 78).

*Tachina.* The species of this genus resemble the Ichneumonidæ in habits, being parasitic in the larvæ of other insects. (21, 53).

HIPPOBOSCIDÆ (*The Forest-flies and Sheep Ticks.*)

Note pecular mode of development. Examine specimens.

# Order COLEOPTERA.

(*Beetles.*)

CHAR. Wings four, anterior pair (elytra) meeting in a straight line down the back. Elytra much thickened forming a case, under which the posterior wings are longitudinally and transversely folded. Posterior wings membranous.

Mouth-parts formed for biting.

Metamorphosis complete.

Only a few variations from these typical characters exist in this order. The following are familiar examples: In Meloë the elytra overlap each other. In many of the Carabidæ, Curculionidæ, &c., the posterior pair of wings are wanting, and in some the elytra are soldered together. The female of the Glow-worm is wingless. And in Buprestis the posterior wings are only longitudinally folded.

This order is the highest of the mandibulate series. The mouth-parts are all well developed. We do not find some of these organs enormously enlarged at the expense of others, as is the case in insects we have already studied.

Larvæ usually furnished with six thoracic legs, and often with a single terminal prop-leg. Some, however, as the larvæ of the Curculionidæ, are entirely destitute of articulated legs. Mouth-parts same as in the adult except that they are more rudimentary.

The pupæ have the wings and legs free, and usually transform in rude cocoons made of earth or bits of wood fastened together by a viscid substance excreted by the larvæ. Many wood burrowing species transform in the tunnels made by the larvæ. A few species (some Coccinellidæ) transform in the old larva skin.

The habits of the insects comprising this order are various. We find among them some of the most beneficial insects as well as some of the most noxious.

The number of living species has been estimated at between 60,000 and 80,000. In the Check List of the Coleoptera of America, North of Mexico, by G. R. Grotch, 7,450 species are enumerated as belonging to that region.

The order is divided into many families, only a few of which can be discussed here.

### CICINDELIDÆ (*Tiger Beetles.*)

Green, purplish or black beetles, with large heads, prominent eyes, large mandibles armed with strong teeth, and the terminal hook of the maxillæ articulated at its base. The elytra are usually marked with white or yellow bars, lunules or dots. The legs are long and slender. They frequent dry sandy places, the banks of streams and road sides. They are predaceous, capturing their prey either by running or flying.

The larvæ also are predaceous, capturing their prey by lying concealed at the entrance of a hole which they dig in the ground. They may be recognized by a dorsal hook on the fifth abdominal segment.

Our common species belong to the genus Cicindela.*

### CARABIDÆ (*Ground Beetles.*)

The beetles of this family vary much in appearance. The most familiar examples are the long-legged black beetles, so common under sticks and stones. Most species are predaceous, and thus render great service to the agriculturist. They run very swiftly. In many species the wings are wanting, and in some the elytra are soldered together.

*For a synopsis of the native species of Cicindela. See Say's Entomology Vol. II., p 415.

1. Faire de cette formule [illegible] dilatabilité (Chapitre 1, §)

The larvæ are found in the grass, and under sticks and stones. They are also predaceous, sometimes overpowering insects many times as large as themselves. (1, 430; 14, I., 57).

The Caterpillar Hunters, *Calosoma and Carabus.*

The Bombardier beetles, *Brachinus.*

DYTISCIDÆ (*The Diving Beetles or Water Tigers.*)

Beetles of an oval, flattened, elliptical or rounded form. They are aquatic, carnivorous, and closely related to the Carabidæ, differing from them only in the form of the large posterior coxæ, and the oar-like natatorial legs. Posterior legs usually compressed and elongated. Note mode of respiration, flight, &c.

Larvæ very active, long, cylindrical, provided with very long sickle shaped mandibles. They are carnivorous, and well merit their popular name, Water Tigers.

Pupæ in round cells in the ground. (1, 435; 14, I., 93).

GYRINIDÆ (*Whirligigs.*)

Beetles of an oval form, and usually brilliant bluish black color. Legs fitted for swimming; anterior pair very long, middle and posterior pair short, broad and much flattened. Aquatic. Note differences in habits between this and preceeding family.

"The cylindrical eggs are placed by the female, end to end, in parallel rows on the leaves of aquatic plants, and the larvæ are hatched in about eight days. They are myriapodous in form, with a pair of large, long,

lateral respiratory filaments on each segment. They became fully grown in August, crawl out of the water and spin an oval cocoon, within which the pupa remains a month, and then appears as a beetle." (1, 436; 14, I., 105).

### HYDROPHILIDÆ.

Aquatic beetles of an ovate or hemispherical and convex form. Legs of moderate length, middle and posterior pairs sometimes fitted for swimming. The adult insects feed upon decaying vegetable matter.

The eggs are placed in a silken nidus spun by the female. Larvæ carnivorous. (1, 437; 14, I., 122).

### SILPHIDÆ (*Carion, or Sexton Beetles.*)

These beetles may be recognized by the depressed form of their heads and bodies, by their clavate antennæ, and by a disgusting odor. They are found in the vicinity of carion, upon which they and their larvæ feed. (14, I., 135).

Note habits of the Burying-Beetles, *Necrophorus*.

### STAPHYLINIDÆ (*Rove-Beetles*).

Beetles with long bodies, and very short elytra, under which the long wings are folded when not in use. They are mostly minute. They feed upon decaying animal and vegetable matter, and are common under sticks, stones, and in the neighborhood of carion. The adult insects have a habit, when frightened, of raising

their abdomens, in a threatening manner, as if they could sting.

Eggs large. Larvæ resemble the adult insects, and are found in similar situations. "In the pupæ the hind wings are not folded beneath the elytra, but extend below, meeting upon the breast." (1, 449; 14, I., 162).

## Scarabæidæ, or Lamellicornia.

This very large family is characterized by the form of the antennæ, which are from 7 to 11 jointed, the external joints, usually three in number, expanded into flat plates, which may be closely applied together so as to form a club.

"Tumble-bugs," *Phaneus carnifex* MacLeay.—Eggs laid in balls of manure, which the female rolls away and buries. Larvæ feed upon the manure.

The May-beetle, *Lachnosterna quercina* Knoch.—Eggs, forty or fifty in number, deposited in the ground. The larvæ, "White Grubs," feed upon the roots of grass, corn and vegetables. These insects live three years in the larva state, and but a short time as pupæ. The adult insects are voracious, feeding on the leaves of trees. (6, I., 60; 3, I., 156; 2, 30).

The larvæ of this insect are destroyed by a fungus. (5, I., 207; 3, I., 158).

*Remedies.*—Hogs will destroy the grubs. The beetles may be shaken from the trees, and easily gathered.

*Dynastes Tityus* Linn.—This beetle is remarkable for its large size. The larvæ live in the trunks of decaying trees. Habitat, Southern States.

### BUPRESTIDÆ.

The species of this family are, in general, elongate in form, and ornamented with metallic colors; head immersed in the thorax to the eyes; antennæ eleven-jointed, serrate; legs short.

The larvæ perforate the stems of living plants. The perfect insects may be found, during the hotter seasons of the year, on flowers, or sunning themselves on trees.

The following species is worthy of especial notice.

The Flat-headed Apple-tree Borer, *Chrysobothris femorata* Fabr.—Eggs laid upon the trunks and principal limbs of trees, during the month of June and the early part of July. The larvæ bore into the bark and into the soft sap-wood. Later they bore into the more solid heart-wood. These larvæ are much enlarged, and flattened anteriorly. Note shape of tunnel.

The perfect insects appear in one year from the time the eggs were laid.

This species infests apple, peach, oak, soft maple, and other forest trees.

*Remedies.*—Dig larvæ out with a knife or gouge. Rub soap on the trees; this will keep the female from depositing her eggs upon them. (3, I., 46; 4, I., 25; 5, II., 146; 6, I., 26, 47).

### ELATERIDÆ (*Click-Beetles*).

These beetles resemble, in form, those belonging to the Buprestidæ. The body is, however, narrower and more elongated than in that family, and usually of a dull color. Many species have the power, when placed upon their backs, of leaping into the air. Hence their

popular names, "Skip-jacks," "Click-beetles" and "Snapping-bugs;" also their scientific name, Elater.

The larvæ are well known under the name of Wire-worms. They feed on the roots of various plants, and are sometimes very noxious.

*Remedies.*—Sow buckwheat or white mustard on the infested field. The larvæ may be trapped with potatoes. (4, XI., 519).

### MELOIDÆ.

These beetles may be characterized as follows: Body soft; head broad, much bent forward, abruptly narrowed posteriorly into a small neck; prothorax narrower than the elytra; elytra soft and flexible; legs long and slender; claws of the tarsi usually divided.

These insects are remarkable for secreting a vesicatory principle, used in medicine, and for the parasitic habits and wonderful transformations of their larvæ.

Note carefully habits and metamorphoses of Meloë. (1, 477; Newport in Linnæan Trans., XX., p. 297, and XXI., p. 167; M. Fabre, "Memoire sur l'Hypermétamorphose et les mœurs de Méloïdes," Annales des Sciences Naturelles, ser. 4, vol. VII., 1857, p. 299).

Several species of Blister-Beetles, *Lytta*, are destructive to potato vines.

*Remedies.*—Drive the beetles into a windrow of hay or straw, and kill them by setting fire to it. Plant early varieties. (3, I., 99; 2, 135; 5, I., 23).

The Spanish-fly, *Lytta vesicatoria* Linn., belongs to this family.

### CURCULIONDÆ (*Weevils, or Snout-Beetles*).

The members of this family may be easily recog-

nized by the head being lengthened into a long snout, at the end of which the small mouth-parts are placed. The antennæ are long, slender, and elbowed. The body is very hard, and usually of a rounded form.

The larvæ are usually footless, furnished with fleshy tubercles instead of legs. They feed on seeds, fruits, leaves and bark, and when full grown spin silken cocoons, within which they transform.

The family is a very large one, nearly 10,000 species having been described. The species are mostly of small size, and many of them are very noxious.

The Plum-Weevil, or Curculio, *Conotrachelus nenuphar* Herbst.—Eggs deposited as follows: The female makes an incison, with her snout, through the skin of the fruit. In this incision she lays a single egg, which she pushes, with her snout, to the bottom of the cavity that she has prepared. She then makes a crescent-shaped incision in front of the one containing the egg. The last made incision undermines the egg, leaving it in a little flap.

Object of the crescent-shaped incision?

The larvæ live inside the fruit, causing it, except in the case of cherry, to fall. When full grown, the larvæ usually leave the fruit and go into the ground to transform. A few transform within the fruit.

The pupa state lasts about three weeks.

This species infests nectarines, plums, apricots, cherries, peaches, black-knot on plum trees, and some kinds of apples, pears and quinces.

*Remedies.*—Hogs. Hull's Curculio-catcher. Ransom Chip-trap Process. (1, 488; 2, 75; 3, I., 50; 3, V., 25; 5, I., 11; 5, II., 130).

## CERAMBYCIDÆ, or LONGICORNIA.

These beetles "are readily recognized by their oblong, often cylindrical bodies, the remarkably long, filiform, recurved antennæ, and the powerful, incurved mandibles. Their eggs are introduced into cracks in the bark of plants by the long, fleshy, extensile tip of the abdomen. The larvæ are long, flattened, cylindrical, fleshy, often footless, whitish grubs, with very convex rings, the prothoracic segment being much larger and broader than the succeeding, while the head is small, and armed with strong, sharp mandibles, adapted for boring like an auger in the hardest woods." (1, 493).

The larvæ live from one to three years before transforming. They transform either within their burrows or within a cocoon made of chips, at the end of their burrows.

*Rhagium lineatum* Oliv.—Common in old pine trees at Ithaca. The larvæ bore in the wood, and undergo their transformations within cocoons, made of chips, between the bark and the wood. The pupæ change to beetles in the fall, but do not leave the tree until spring. (2, 116).

The Round-headed Apple-tree Borer, *Saperda candida* Fabr. (*Sperda bivittata* Say).—Eggs laid on the bark of the tree near its base. Larvæ bore through the bark into the sap-wood, where they at first make a disk-shaped burrow; afterwards they make a tunnel in an upward direction in the harder wood, coming to the surface several inches above the place they entered. The larvæ live three years. They change to pupæ

Segunda izquierda - abr.

(at Ithaca) about the middle of May. The perfect insect escapes early in June.

This species infests apple, quince, pear, June-berry, mountain ash and hawthorn.

*Remedies.*—Same as for the Flat-headed Borer, except that the soap need be applied only to the base of the trees.

(1, 500; 3, I., 42; 4, I., 11; 4, III., 321; 6, I., 26, 47).

The Oak-pruner, *Elaphidion villosum* Fabr. (2, 98).

The Girdler, *Oncideres cingulatus* Say. (1, 498; 5, I., 76).

### CHRYSOMELIDÆ (*Leaf Beetles*).

"The Leaf-Beetles are oval or oblong, often very thick and convex above, with short antennæ, round, prominent eyes, with a narrow, cylindrical thorax, and the hinder thighs often much thickened in the middle, while the abdomen has five free segments.

The larvæ are short, rounded, cylindrical or flattened, generally of soft consistence, usually gayly colored, and beset with thick flattened tubercles or branching spines, and well developed thoracic feet. There are estimated to be from 8,000 to 10,000 species. They are found feeding, both in the larva and adult stages, on leaves, either on the surface, or, as in Hispa and several species of Haltica, their larvæ are leaf-miners." (Packard, 1, 501).

The Three-lined Leaf-Beetle, *Lema* (*Crioceris*) *trilineata* Oliv.—The beetles appear in June, and lay their eggs in small clusters, six or eight in a cluster, on the leaves of the potato. The larvæ feed on the leaves, and may be easily recognized by a habit they have of

covering their backs with their own excrement. They transform in the ground in earthen cells. The perfect insects appear in August, and lay eggs for a second brood, which hybernates in the ground as pupæ. (2, 118; 5, I., 26; 6, II., 25).

The Colorado Potato-Beetle, *Doryphora decem-lineata* Say.—The eggs are laid in clusters on potato leaves, upon which both larvæ and the perfect insects feed. The larvæ go into the ground to transform. There are three broods each season. The last brood remains in the ground during the winter, usually in the beetle state; a few, however, hybernate as pupæ.

Original habitat, Rocky Mountains. Note manner of its march eastward.

*Remedy.*—Paris green.

(1, 508; 3, I., 101; 3, IV., 5; 4, IX., 229; 5, I., 41; 5, II., 289; 6, I., 1; 6, I., 84; 6, II., 13).

For a discussion of the poisonous qualities of the Colorado Potato-Beetle, and treatment of poisoning, see E. M. Hale, M. D., in the Trans. of the Hom. Med. Soc. of the State of N. Y., vol. VII., (1869), p. 142.

The Striped Squash-Beetle, *Diabrotica vittata* Fabr. (1, 505; 5, II., 24).

The Cucumber Flea-Beetle, *Haltica* (*Crepidodera*) *cucumeris* Harris. (1, 506; 2, 127; 3, I., 101; 5, I., 27).

## Coccinellidæ ("Lady-Birds").

These insects are well known to nearly every child, under the popular name given above. They are hemispherical, generally red or yellow, with black spots, or black, with white, red or yellow spots. They are very

beneficial, both in the larva and adult states, feeding upon plant-lice and the eggs of other insects.

The larva, when full grown, attaches itself to a leaf, and either casts off its skin, which is collected in a mass at its tail, or undergoes its transformations within the larva skin.

Two very common species (at Ithaca) are the Nine-spotted Coccinella, *Coccinella novemnotata* Herbst, and the Spotted Hippodamia, *Hippodamia maculata* De Geer. (1, 511; 14, I., 395).

## Order HEMIPTERA.

(*Plant-lice, Bugs, "Locusts," &c.*)

CHAR. Wings four, anterior pair either of the same thickness throughout, and, usually, sloping at the sides, or thickened at the base, with thinner extremities which overlap on the back.

Mouth-parts formed for sucking.

Metamorphosis incomplete.

This order contains many anomalous forms. So great are the variations that in several instances, groups that are here considered as families have been regarded as orders. Some of these variations will be noticed in the discussion of the different families.

The Hemiptera may be divided into two sub-orders,—the Homoptera, and the Heteroptera. These groups are called orders by Westwood and other English writers.

### SUB-ORDER HOMOPTERA.

CHAR. Hemiptera having the anterior wings of the same thickness throughout, and, usually, sloping at the sides.

Mouth-parts inserted at the posterior and inferior portion of the head.

We find in this sub order many wingless forms, while some are Dipterous.

The mouth-parts consist, typically, of a short, pointed labrum, and four setiform organs (mandibles and maxillæ) enveloped in a long, fleshy, ar-

ticulated sheath (labium). The maxillary and labial palpi are obsolete. In some species the mouth-parts are almost as long as the body.

The larvæ resemble the adult insects but, at first, want wings. Rudiments of these begin to appear after the first moult, and with each successive moult they are further developed.

The pupæ are active and differ mainly from the larvæ in having larger wing-pads. A remarkable exception occurs in the case of the male Coccus, the larvæ of which spins a silken cocoon, and changes into an inactive pupa. (1, 517).

All the insects of this sub-order are terrestrial, and live upon vegetable juices. Many are remarkable for covering themselves with excretions from their bodies. The females are often furnished with a complicated ovipositor.

Examples of the three more important families will be noticed.

## APHIDÆ (*Plant-lice*).*

The small green plant lice, so common on plants, both in the fields and in the house, are familiar examples of this family, and will serve as illustrations of the typical form of its members.

Plant-lice are found on nearly all parts of plants,—the roots, stems, buds, leaves, and flowers. They derive their nourishment by sucking the juices of the plants, and are sometimes very injurious, as their powers of reproduction are immense. (1, 519; 14, II., 437; 8, III., 281—412; 8, VI., 523; 2, 232).

Many of our common species belong to the genus Aphis, which may be recognized by the long honey-tubes, the presence of the fourth or stigmal vein of the anterior wings, and the seventh, or last, joint of the antennæ being longer than the sixth joint.

The mode of reproduction in this group has been carefully studied, and presents some striking peculiar-

* See paper entitled "On the genera of Aphidæ found in the United States," by Benj. D. Walsh, 10, I., 294.

ities. In the spring there are produced, from eggs laid the previous autumn, wingless individuals. These are all of the same form (sex), and give birth to living young. The second and succeeding generations are like the first, until in the early autumn when there is produced a brood of winged individuals. This brood consists of both males and females. These pair; the males then die, the females lay eggs after which they die. The eggs hatch in the following spring, and produce the agamic wingless form.

The species of Aphis infest both the foliage and the roots of plants.

Ants and Aphides (5, I., 110; 7, 335).

The principal enemies of the plant lice are Ichneumon-flies, Syrphus-flies, "Lady-birds," and the Aphis-lions (Chrysopa).

*Remedies.*—Tobacco smoke. Strong soap-suds.

Many members of this family produce galls. The following species is the most noted example, and will serve to illustrate the habits of the gall-making species:—

The Grape Phylloxera, *Phylloxera vastatrix* Planchon.—Two constant types: One, called *gallæcola* by Riley, lives in galls on the leaves. This form was described, by Dr. Asa Fitch, under the name of *Pemphigus vitifoliae.* (4, I., 158; 4, III., 397). The other form is called *radicicola*, by Riley, and infests swellings of the roots.

*Type Gallæcola or Gall-inhabiting.*—This type occurs only as an agamic, wingless female.

Note manner of development of the young lice, and of the galls.

The autumnal individuals of gallæcola descend to the roots, and there hibernate.

*Type Radicicola, or Root-inhabiting.*—Of this type there are two forms: First, a degraded, or wingless form; second, a perfect, or winged form. In early spring the first form is developed from eggs laid in the autumn, or from larvæ that have hibernated. After three or four generations of the wingless form have been produced, the winged form makes its appearance. Of this form there are both males and females.

The injury done to the vine by radicicola is much greater than that done by the gall-inhabiting type.

*Remedy.*—No efficient remedy has yet been discovered. (3, VI., 30).

### COCCIDÆ (*Bark-lice*).

The following well known species is described as an illustration of the forms and habits of these anomalous insects.

The Oyster-shell Bark-louse of the apple, *Mytilaspis pomicorticis* Riley (*Aspidiotus conchiformis* Gmelin).—This insect is best known by the scale which it excretes. This scale is small, oblong, flattish, of an ash-grey color, and shaped like an oyster-shell. It occurs in great numbers on the bark of apple trees, and covers, during the winter and spring, a number of small, round, white eggs.

The eggs hatch in the latter part of May, or early in June.

The young louse is oblong-oval in form, one-hundredth of an inch in length, and furnished with seven jointed antennæ, and six legs.

Note manner of excretion of the scale.

The female larva, by a retrograde development, loses its antennæ and legs, becoming a rounded, swollen, and almost memberless creature. As the eggs are deposited, the body of the louse shrinks, and finally occupies only a small space, at the anterior or narrow end of the scale. The eggs are deposited during the month of August. This insect is single brooded in the North, but double brooded in the South.

The male larva develops into a dipterous individual, furnished with halteres, and with the mouth-parts obsolete.

Note differences between the scales formed by the males and those formed by the females.

The enemies of this species are mites, lady-birds, and a chalcis-fly, *Aphelinus mytilaspidus* Le Baron.

*Remedies.*—Scrape and prune the infested trees, and afterwards apply some oily substance; as linseed oil or lard. The oil is absorbed through and under the scales, and destroys the eggs. This may be done in the winter, but it is better to do it in early spring, after the sap begins to flow.

A strong solution of soap will kill the young lice if applied during the period of hatching. (3, I., 7; 3, V., 73; 1, 528; 2, 252).

## CICADARIÆ ("Locusts").

The members of this family are remarkable for their large size, being the largest of the Homoptera, and for the musical apparatus of the males.

The following are the most common species.—

The seventeen year locust, *Cicada septendecim* Linn. —Eggs laid in the twigs of various trees. For a care-

ful description of the manner in which this is done, see Harris 2, 211.

The larvæ hatch in about six weeks. They voluntarily drop to the ground, where they bury themselves. The period that they remain here wants only a few weeks of being seventeen years. They derive their nourishment, during this time, from the roots of different plants. The larvæ are sometimes found at great depth,—five to ten feet.

Note form of galleries, and the extensions of them above the ground, which the pupæ sometimes build.

They emerge from the ground during the last half of May, at which time the empty pupa-skins may be found, in great numbers, clinging to bark of trees, and to other objects. They pair, the females oviposit, and all disappear in a few weeks.

The injury done to fruit trees, by the females, when depositing their eggs, is sometimes very great.

These insects are called locusts only in America. The locusts of other countries belong to the Orthoptera, and are what we call grasshoppers. Keep this fact in mind when reading European works. (3, I., 18; 4, I., 38; 5, I., 63).

The thirteen year locust, *Cicada tredecim* Riley, is the name given to a variety of *C. septendecim* which matures in thirteen years. (3, I., 18).

The Dog-day Harvest-fly, *Cicada pruinosa* Say.—This is the common species in Ithaca. It is larger than *C. septendecim*. The top of the head and thorax is marked with green lines; and the veins on the basal half of the anterior wings are of the same color. The veins beyond the middle of the wings are brownish. The body beneath is pruinose, hence the specific name.

The injuries done by this insect are small in comparison with those done by *C. septendicim.* It appears, in the perfect state, later in the season than the seventeen year species. The popular name is indicative of the time it appears. (2, 217).

## SUB-ORDER HETEROPTERA.

CHAR. Hemiptera having the anterior wings thickened at the base, with thinner extremities which overlap on the back.

Mouth-parts inserted at the anterior and inferior portion of the head.

In this sub-order there are many wingless, parasitic forms; there are also many aquatic species.

The form of the mouth-parts is typically the same as in the Homoptera, but the position of these organs is different, as indicated above.

The character of the metamorphosis, which these insects undergo, is similar to that of the Homoptera.

Most of the terrestrial species emit, when handled, a disgusting odor. The taste of these insects is equally disgusting, as all can testify who have accidentally put them in their mouths with berries or other fruit.

Representatives of two of the families will be described.

### CORISIDÆ.

Only two species of this very extensive family can be described in this course:—

The Chinch-bug, *Rhyparochromus leucopterus* Say. —The form and appearance of this insect is too well known in many parts of the country. Length of perfect insect 4 m. m.; body narrow, black, with white wings.

. Eggs deposited under ground. They are yellow

and about five hundred in number. The female is three weeks laying them. They require about two weeks to hatch.

The larvæ are red, and, at first, feed upon the roots of the plants which they infest, sucking their juices; afterwards they attack the stalks. The bug becomes full grown in from forty to fifty days.

This species is two or more brooded and hibernates in the perfect state. It infests the different kinds of grain, destroying the small grains first, then attacking corn.

Although the perfect insect has well developed wings, it seldom uses them for flight.

Note habit of marching from one field to another.

This species is dimorphic, there being a short winged form.

*Natural enemies.*—Several species of lady-birds, the Weeping Lacewing (*Chrysopa plorabunda* Fitch), the Insidious Flower-bug (*Anthocoris insidiosus* Say), and the common Quail.

*Remedies.*—Burn corn-stalks, and rubbish along fences, in order to destroy the bugs that are hibernating in those places. In case a field of grain is so badly infested as to be not worth harvesting, do not fail to burn it. With twelve bushels of spring wheat mix one bushel of winter rye. The bugs will destoy the rye in preference to the wheat. Note manner of stopping their march with boards, and of trapping them in pits. (5, I., 169; 3, II., 15; 4, II., 277).

The Squash-bug, *Coreus tristis* De Geer.—Eggs laid in June, in little patches, on the leaves. Young bugs short and more rounded than the adult insects, and of

a pale ash color. The perfect insects have long narrow bodies. They are blackish brown above, and dirty yellowish beneath. There are several broods each season. They leave the plants in October, and hibernate in the perfect state.

### THRIPIDÆ (*Thrips*).

This family constitutes the order Thysanoptera of authors. The insects comprising it are very minute, rarely exceeding 2. 5 m. m. in length. The body is long and linear; wings narrow, membranous, furnished with long cilia; and laid horizontally on the back when not in use; mandibles setiform; maxillæ flat, triangular, and furnished with palpi; labial palpi also present.

These insects are common on flowers, especially daisies and clover. Their long bodies, and curious habit of turning up their abdomens when frightened, remind one of the smaller species of the Staphylinidæ Some species are beneficial, preying upon noxious insects, others are injurious to vegetation.

The Grass-eating Thrips, *Limothrips poaphagos* Mss., destroys the heads of timothy and June-grass. The young insect pierces the stem just above the node where it is tender, and, sucking the juice from it, causes it to shrink and all the parts above the injury to die.

The Bed-bug, *Cimex lectularis* Linn. (Fam. *Membranacei*), and the different species of lice, *Pediculus*, (Fam. *Pediculina*) are low wingless forms, belonging to this sub-order.

## Order ORTHOPTERA.

(*Crickets, Grasshoppers, Cockroaches, &c.*)

CHAR. Wings four, anterior pair thickened and usually overlapping. Posterior wings thinner, and folded in plaits longitudinally.

Mouth-parts formed for biting.

Metamorphosis incomplete.

The name Orthoptera, straight wings, is given to this group on account of the longitudinal folding, and position of the posterior wings when not in use.

There are many wingless genera. A few species have the anterior pair only, and, in at least one instance, the anterior wings are wanting while the posterior pair are present. In the earwigs the anterior wings are thickened, and meet in a straight line down the back, resembling the elytra of beetles.

The mouth-parts are all present, and well developed.

The larvæ resemble the adult insects, but want wings. The pupæ are active and have rudiments of wings.

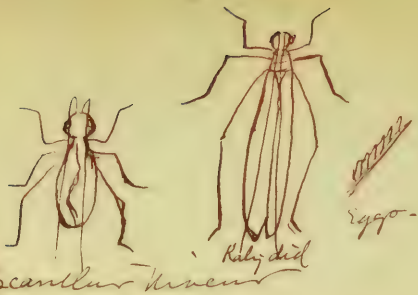
All the members of this order are terrestrial. The Mantidæ are predacious; the remaining families are chiefly vegetable feeders.

The insects belonging to the first section are interesting on account of the sounds that they produce. They "stridulate in four different ways: first, by rubbing the base of one wing-cover upon the other, using, for that purpose, the veins running through the middle portion of the wing; second, by a similar method, but using the veins of the inner part of the wing; third, by rubbing the inner surface of the hind legs against the outer surface of the wing covers; and fourth, by rubbing together the upper surface of the front edge of the wings and the under surface of the wing-covers. The insects which employ the fourth method

Orthoptera. The Cervical-order of
Insects. Grasshoppers
ing tarsal limbs of grasshoppers
for jumping - in walking sticks
the legs are weak - not - fitted
for locomotion so much -
Legs of mole crickets - adapted to
digging.

Comparison of stridulating
to a violin.
The vibrating bodies are the membranes
stretched between the veins.
The grasshopper have a
resonator for intensifying the
sound -

Femur of grasshopper - grooved
to receive the femoral - tibia




Katy-dids cannot jump very far - legs are weak. In this group there are many whose wings mimic the leaves. Some even mimic the discoloration & imperfection of leaves - K. dids eggs are coated with an albuminous [illegible]

stridulate during flight, the others while at rest. To the first group belong the Crickets (Gryllidæ); to the second, the Green or Long-horned Grasshoppers (Locustariæ); to the third and fourth, certain kinds of Short-horned or jumping Grasshoppers (Acrydii)." (Scudder, 17, II., 114).

The true Orthoptera may be divided into four sections:—*Saltatoria*, legs formed for leaping; *Ambulatoria*, legs formed for walking; *Raptoria*, fore legs formed for grasping; *Cursoria*, legs formed for running.

The Earwigs, *Forficulariæ*, if considered members of this order, constitute a fifth section.

The first section, *Saltatoria*, includes three families. There is much confusion regarding both the scientific and common names of these families as shown by the following table:

| AUTHORS. | FAM. I. | FAM. II. | FAM. III. |
|---|---|---|---|
| *Latreille.* | GRYLLIDES. | LOCUSTARIÆ. | ACRYDII. |
| *Leach.* | ACHETIDÆ. | GRYLLIDÆ. | LOCUSTIDÆ. |
| *Scudder.* | GRYLLIDES. Crickets. | LOCUSTARIÆ. Green or Long-horned Grasshoppers. | ACRYDII. Short-horned or Jumping Grasshoppers. |
| *Packard.* | GRYLLIDÆ. Crickets. | LOCUSTARIÆ. Locusts. | ACRYDII. Grasshoppers. |
| *Harris.* | ACHETADÆ. Crickets. | GRYLLIDÆ. Grasshoppers and Katydids. | LOCUSTADÆ. Locusts. |
| *Thomas.* | GRYLLIDÆ. Crickets. | LOCUSTIDÆ. Grasshoppers. | ACRIDIDÆ Grasshoppers. |

## I. SALTATORIA (*Jumpers*).

This section of the Orthoptera includes those species that have the anterior and middle legs short, and the posterior legs long, formed for leaping. The femora of the posterior legs are greatly thickened, so as to give room internally for the action of large, strong muscles, and channeled for the reception of the tibiæ, when at rest. The tibiæ are furnished, on the upper and posterior surface with strong spines; the tibial

spurs are large, enabling the insect to get a firm foothold, preparatory to leaping.

### GRYLLIDÆ (*Crickets*).

Saltatorial Orthoptera with long, slender antennæ; wings horizontal, with the outer portion of the anterior pair bent abruptly downwards; tarsi three jointed (except in Œcanthus, which has the hind tarsi four-jointed); ovipositor, usually long, spear-shaped.

Crickets are chiefly solitary, nocturnal insects. They usually feed upon plants, but are sometimes predacious. Most of the common species lay their eggs in the ground; the Tree crickets oviposit in twigs, vines, etc. The eggs are laid in the autumn and hatched in the following summer. The greater part of the old crickets die on the approach of winter; a few hibernate. (2, 150).

Note form of the musical apparatus of the males.

The black cricket, which is so common in Ithaca, is *Gryllus abbreviatus* Serv. Another species found here is *Gryllus luctuosus* Serv. This species is easily recognized by its long wings, which are much longer than the wing-covers, and project beyond the extremity of the abdomen.

The Mole-crickets, *Gryllotalpa*, are so named on account of their large, fossorial fore feet, and burrowing habits. They live in moist places, excavating extensive burrows in search of their food. They feed upon the roots of plants and upon insects. "Their eggs, from 300 to 400 in number, are laid in the spring in tough sacks, in galleries, and the young do not come to maturity till the third year." (1, 563; 2, 149).

Spec.

The Snowy Tree-cricket, *Œcanthus niveus* Serv.—

Eggs laid in a longitudinal series in raspberry canes, causing the death of that part of the plant which is beyond the punctures. The eggs are laid in the autumn; the young crickets appear (at Ithaca) during the month of June (June 15th, 1873); the perfect insect may be found early in September (Sep. 9th, 1873). This species is predacious, feeding upon plant-lice and eggs of insects. Prof. Riley states that females oviposit in the twigs or canes of the grape-vine, apple, peach, blackberry, white-willow and soft-maple, as well as those of the raspberry. (3, V., 120).

LOCUSTARIÆ (*Green or Long-horned Grasshoppers*).

Saltatorial Orthoptera with long, slender antennæ; wings, when at rest, slanting like a roof; tarsi four-jointed; ovipositor, generally long, compressed, sword shaped.

The Long-horned Grasshoppers are mostly of a green color, their wings often resembling leaves. Like the crickets, they are chiefly nocturnal, solitary, phytophágous insects. They live on grass and other herbaceous plants. Their eggs are laid either in the ground or in various parts of plants. A few of the larger species, called Katydids, inhabit trees and shrubs. (2, 155; 3, VI., 150).

One species of Katydid, *Microcentrum retinervis* Burm. attaches its eggs externally in a double row to twigs. From eggs of this insect received from New Jersey, I have bred a Chalcis-fly, *Antigaster mirabilis* Walsh. (5, II., 368).

Several genera, belonging to this family, are wingless. *Ceuthophilus maculatus* Say is a common, wingless species, found under stones.

ACRYDII (*Short-horned Grasshoppers or Locusts*).*

Saltatorial Orthoptera with short, not more than twenty-four jointed antennæ; wings deflexed; tarsi three-jointed; ovipositor short.

The Locusts are the best known of the Saltatoria, they being diurnal and occurring in great numbers, in meadows and pastures. They are able to leap much better than the long-horned Grasshoppers; and some species have great power of flight.

Note manner of stridulating.

The eggs, fifty to one hundred in number, are generally laid in the ground, in a mass covered with a tough, glutinous secretion. They are long and cylindrical in form. Some species excavate holes in rails, logs, etc., in which they lay their eggs. (2, 165; 1, 567; 7, 125).

Note habits of the following species:—

The Hateful Grasshopper, *Caloptenus spretus* Uhler. (6, II., 3; 5, I., 73, 94; 5, II., 81).

The Red-legged Locust, *Caloptenus femur-rubrum* Burm. (2, 169).

Each of the following sections contains only a single family.

## II. AMBULATORIA (*Walkers*).

### PHASMIDA (*Walking-sticks*).

The Walking-sticks, or Spectres are easily recognized by their long, linear bodies, furnished with long legs and antennæ. Their wings, when present, are small, or if large, very leaf like, resembling, in some

* See "Synopsis of the Acrididae of North America." By Cyrus Thomas, Ph. D. Published by the Department of the Interior.

Locusts - can fly making long journeys. Acrydii are gregarious and very destructive - when they have eaten all there is they fly (by) to other world & conquer -
[illegible] Stridulate - with the legs against the wing. Chewing + digestive apparatus very excellent + complex.

Locust - { Homologa / Burnt place }

3600 years before Christian era - great depredations made by locusts.

New England has suffered greatly from these locusts. - Difference between European migratory grasshoppers + our European ancestor genera.

Gr. { (Dictyophora — migratoria (Locusta) / Acridium — peregrinum }

Migratory grasshoppers of U.S. are Caroliensis. Two species have been recognized.

Calopleurus femoratus, extends from Great Basin to Missouri R.

Calopleurus spretus from Missouri River to Rocky Mts. but not extending to the pacific slope.

Cal. fem. Rv. prefers damp land. & salt-marshes - advances from low lands to the highlands - eating or liking grass.

Cal. spretus, seems a variety of femoratus.

" " has a notch in last seg. of the abdomen - wings longer - but these are variations of both species & make connecting links. Odours differ from that resembles western Cal. femoratus - The two sexes Cal f.r. & Cal spret. seem reduced by climate. Cal. f.r. do not seem to suffer such severe changes. Cal spretus is adapted to a high & dry climate. The mosquito stalks are very changeable in climate - & hence the changes in grasshoppers. but throughout that central region neither species will succeed in living.

in 1747 - Locusts came from Asia Min. Arabia - thence to Sweden - Germany - in 1748 reached central Germany - so year after year they moved on - In 1855 - the Manitoba (Red R. of North) was infested in 1858 - the upper Missouri was infested - 1864 these same regions were all infested & the whole reached Missouri - 1864 - Nebraska - Kansas & Texas &c &c - Thus showing a progressive course from year to year - - The region where their hatching grounds where they are best adapted to live - is from Col. North to lat 18°. Lon. on sandy plateaus - (narrow region) The insects is so large that they cannot be killed there. They do not travel more than 200 miles in a hundred miles per year & will the prevailing winds

instances, fresh green leaves, in others, those that are dry and withered. The wingless species resemble twigs.

*Diapheromera femorata* Say is a wingless species quite common in Ithaca.

### III. Raptoria (*Graspers*).

#### Mantidae (*Soothsayers*).

The Soothsayers, Prophets, or Camel-crickets are readily recognized by the form of their anterior legs, which are especially adapted for grasping, being large, and furnished with strong spines. These insects do not pursue their prey, but wait patiently until it comes within reach, when they seize it. The position which they assume, while waiting, gives them their popular names.

Note habits, form of oötheca, etc. of *Mantis Carolina* Linn. (3, I., 169).

### IV. Cursoria (*Runners*).

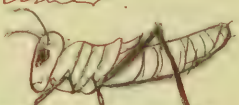
#### Blattariae (*Cockroaches*).

The Cockroaches are well known pests in every part of the country. They are characterized as follows: Body broadly ovate and depressed; legs nearly of equal length; fore wings large, ovate, overlapping; posterior wings longitudinally folded; prothorax large, shield-shaped; antennæ long, setaceous, many-jointed.

Several species are common in fields, under stones; others are found in houses. They are nocturnal, hiding by day, and leaving their retreats at night, in search of food. Those found in houses are gen-

On Uruchby's populated region people may contend against them with some success. Definit. eggs is done in Manitoba region - in March in Texas - (Describe oviposition & mode of oviposition).

The eggs are deposited in an albuminoid substance which after it is dried is insoluble in water, in the pods are deposited in 4 rows with a hard groove on top to allow escape of the earliest hard nymphs. The embryo, aided by spurs on tibia to break its shell: after young moult once the antennae appear. Three moults more.



When young moult last time it attaches itself by a thin band to worn - after this moult it is white & soft but soon dries & gets its proper colors.

Small grains usually mature before the grasshoppers get there. The 2nd year the damages are greater than second [illegible]

Natural Enemies of Cal. Sprel.
are numerous. a little red mite
is a parasite upon them especially
feasts upon the eggs. also in
damp regions (Rain Snake (like a
worm) infest them.
Birds are are the most efficacious
of any enemies but unluckily
there are no birds when they
come down on the plains there
are no birds. Birds like them
while they are young.
English Sparrow especially, yet
Hogs are also very destructive
to them also, rooting after the eggs.
Fight them also by fire - by
burning the paraire when there
are many quite small
Ditching also used - 3 ft. broad -
4 ft water in the ditches drown the
Sheriffs burn them by putting
straw in ditches or drawing a log
through. Premium are given
for bushel. $15.00 for eggs - 1st. $10
2d. - per bushel during April May
June - 2d.

erally considered noxious on account of the injury they do to provisions and clothing; but as they greedily devour bed-bugs, they may, sometimes, be considered beneficial.

Note form of oötheca. (1, 575; 2, 145).

## V.

### Forficulariæ (*Earwigs*).

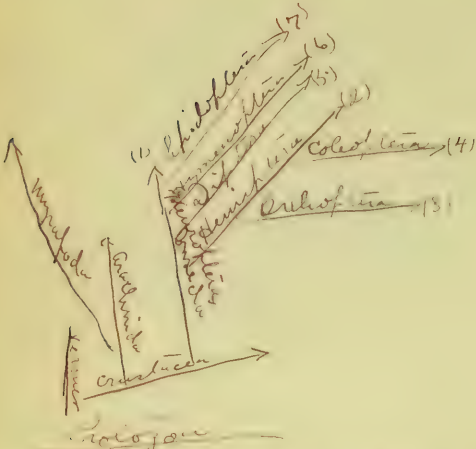
This family differs much from the other Orthoptera, and is considered as a distinct order (*Dermaptera* Leach, *Euplexoptera* Westwood) by many entomologists.

The members of it have long, narrow, flattened bodies. Their wing-covers are thick, short, and meet in a straight line down the back. The extremity of abdomen is armed with large, strong forceps. Hence the generic name Forficula, from which the family name is derived.

The long bodies and short wing-covers of these insects cause them to greatly resemble the Staphylinidæ.

Earwigs are rare in this country, but they are very common in Europe. They are nocturnal and feed on the corollas of flowers, fruits, and other vegetable substances.

Lecture by Dr Bernard.




Embryo Myriapoda have only 8 pairs. Insecta 6 pairs. Their Larvae annul number All Arachnida & Crustacea come to them Spring from. very crude 3 legged Crustacea

## Order NEUROPTERA.

(*Dragon-flies, May-flies, Ant-lions, White Ants &c.*)

CHAR. Wings four, membranous, net-veined, generally large, and of equal size.

Mouth parts formed for biting.

Metamorphosis complete or incomplete.

Abdomen of females with no sting or piercer.

Although we find exceptions to nearly every leading characteristic of this order, the members of it may, in most cases, be easily distinguished from other insects. They are separated from the Lepidoptera, Diptera and Hemiptera by their masticatory mouth-parts; from the Hymenoptera by the equal size of the wings, the greater number of the areolets, the non-possession of a sting or piercer, and the shape of the maxillæ, which do not form a sheath for the labium; and from the Coleoptera and Orthoptera by the anterior wings being membranous.

The Neuroptera is, comparatively, an order of small extent, but includes insects that differ widely in habits. Although, structurally, they are the lowest insects, some of them rival in complexity of habits the highest members of the class. The species are mostly predaceous and can be ranked among beneficial insects.

Only a few of the better known species will be discussed here.

### TERMITIDÆ (*White Ants*).

These insects resemble, somewhat, in form and habits, the ants. They are social, the colonies sometimes containing an immense number of individuals. There are four forms,—male, female, worker, and soldier. The males and females are winged; the workers and soldiers are wingless.

Neuroptera the earliest of all groups of insects - represented in Devonian time - described by Brongniart. In Coal-time no other order of insects known in considerable number, showed developments in many of Orthoptera. Many of these order some of them lived among water-plants, & in this may be regarded the root of this order.

Many of these came very early - sometimes before the snow were off them, & are considered equivalent to several genera of Lower formations, for separation of genera & species. Many of them became identified for plantation. Many Neuroptera are amphibian most of their lives the adult-form only existing for a few days (the Blossom end of a year of life). Pupa usually developed into [illegible] numerous in [illegible] times.

Odonata - prophetic forms appeared in Carboniferous times long before Cretaceous.

Soldiers have very large heads make the workers work & protect the colonies - worker care for the young -

Termites - Comb

M ♀ ♂

Soldier head -
Body like worker

worker - apterā

Under Dr Hagen books on Neuroptera

Note habits of the White Ants of Africa. (7, 304; 20, 404).

Our native species, *Termes flavipes* Kollar, is found in old logs and stumps, and under stones. (4, III., 469; 4, IV., 694).

### Ephemeridæ (*May-flies* or *Ephemerids*).

The May-flies are distinguished as follows:—They have long, slender, soft bodies; the mouth parts are obsolete; the antennæ are small; the wings are of unequal size, the anterior pair being much the larger; posterior wings, in some species, wanting; the extremity of the abdomen is furnished with two or three setæ.

The eggs are laid in the water. The larvæ are aquatic; they live under stones, among aquatic plants, and in burrows in the mud; they are carnivorous, and require two or three years to mature. The pupæ are active, and have rudimentary wings. When ready to transform, the pupa leaves the water, and at once moults, assuming a winged form (pseudimago, or subimago) which, after flying to some neighboring tree or other object, moults again. The perfect insect has more delicate wings, and longer caudal setæ than the subimago.

The adult insects live only a few hours; hence the name. They occur in immense numbers.

### Libellulidæ (*Dragon-flies* or *Devil's-darning-needles*).

The Dragon-flies have long, narrow bodies. The head is large, with enormous eyes; thorax square and bulky; abdomen long, slender, and cylindrical; wings

On Africa the mounds of Termites are 15-20 ft high.

adult- May fly eats nothing in the imago state. Has no alimentary digestive organs.

adult- ♀ drosophila eggs with maternal no alae fluer over 1.

Note clasper on ♂ of Libellulidae

large, and nearly of equal size; posterior pair sometimes the larger.

These well-known insects are very common, flying over ponds, and in the neighborhood of streams, in pursuit of their prey.

The eggs are laid in the water. The larvæ are aquatic and predacious; pupæ active.

Note form of the enlarged labium, or mask, of the larva and pupa, also the peculiar respiratory organs. (1, 597).

SIALIDÆ.

This is a small family, but some of the members of it are the cause of much astonishment and curiosity on account of their large size and bizarre forms.

*Corydalus cornutus* Linn. is a large and very common species. The males are remarkable for the enormous size of the mandibles, which project nearly an inch and a half in front of the head.

The eggs are attached to various aquatic plants. The larvæ are aquatic and carnivorous; they are furnished with both spiracles and branchiæ. When full grown, they leave the water, and undergo their transformations in earthern cells, which they usually make under stones, near the water. The pupæ have rudimentary wings, and are of a much lighter color than the larvæ. (3, V., 142).

These insects, especially the larvæ, are, on account of their great size, good subjects for anatomical study. They differ, however, in some respects from other insects. Note the doubling of the main tracheæ, as described by Packard (17, VIII., 533).*

* I have noticed another remarkable peculiarity of these tracheæ, which, I think, has never been described. The spiral fibre is compound, being composed of several threads placed side by side. When uncoiled from the tracheæ it appears like a striped ribbon.

Dragon-flies. male. the folds of al. canal - used for trachea as the squids & cephalopods - in female [illegible] through the males.

Mandibles of males.

Mole crickets - riding on backs of larvae Corydalus.

HEMEROBIDÆ (*Aphis-lions, Ant-lions, etc.*).

The Aphis-lions, *Chrysopa*.—Eggs placed on stalks, attached to plants. The larvæ are carnivorons, feeding on insect eggs, plant-lice, small caterpillars, and other insects. When full grown, the larva spins a small, white, silken cocoon. In this the pupa remains during the winter. Some species are double brooded; in these the pupa state, of the first brood, lasts about two weeks. The perfect insect escapes from the cocoon by cutting a lid in one side of it.

These insects are known in the adult state as Lace-winged flies, or Golden-eyed flies. They may be easily recognized by their delicate green bodies, large, lace-like wings, and bright golden eyes. Some species emit a very disagreeable odor. (4, I., 70—96; 3, I., 57, fig. 20).

The Ant-lions, *Myrmeleon*.—The larvæ resemble in form the Aphis-lions. They are able to walk only backwards, on account of the peculiar manner in which the posterior legs are articulated to the body. They are carnivorous, feeding on wingless insects, especially ants, which they trap in pit-falls. These pit-falls are made in fine sand; the larvæ are concealed at the bottom ready to seize any insect that may fall into them.

Note, carefully, manner of digging pit-falls, and other details in the habits of the larva.

The pupa state is passed in a cocoon made of sand, fastened together with silk, and neatly lined with the same material. As with the Aphis-lion, the silk is spun from a spinneret, placed at the posterior extremity of the body.

An Insect Lecture given
by Mr Rumble S catching Aphis
& placing them upon trees infested
by Aphides.

The perfect insect bears some resemblance to a Dragon-fly.

The larvæ may be found, during the entire summer, in sand, at the base of cliffs, in the ravines about Ithaca.

PHRYGANEIDÆ. (*Caddis-worms*, or *Case-worms*).

The members of this family differ so much from other Neuroptera that they are considered by many entomologists as a distinct order, the Trichoptera of Kirby.

Some of the adult insects strongly resemble moths, for which they are often mistaken. The body is hairy; the head is small, with long antennæ, and imperfectly developed mouth-parts; the wings are deflexed at the sides, when not in use; and the legs are long.

The larvæ are very common (at Ithaca) in all our streams, and in the Lake. They are long, cylindrical, soft-bodied, and furnished with six well developed thoracic legs, and a pair of anal legs. The mouth-parts are formed for biting. The abdomen bears numerous respiratory filaments.

The young larva protects its soft body by building a case in which it lives. These cases are composed of various materials, sticks, leaves, stones, shells, etc., fastened together with silk, or are made entirely of silk. Some of them are portable, others are attached to stones or other objects. As the larva increases in size, it enlarges its case by making additions to the anterior end.

Note different forms of cases.

The silk is spun from a spinneret, placed at the

mouth, as with the caterpillars, and not at the other extremity of the body, as it is with the Aphis-lions and Ant-lions.

The larvæ feed upon both vegetable matter and small aquatic animals. The pupa state is passed within the larval case, which is usually fastened to some object, and has the entrance closed with a grating or a silken lid.

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† In the references to these reports, the pages are, except in case of reports 1, 2, 6, 7, 8, and 9, those of the Trans. of the N. Y. State Agri. Soc. for the year in which the report was published.

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